

UNCLASSIFIED

AD NUMBER

ADB004815

LIMITATION CHANGES

TO:

Approved for public release; distribution is unlimited.

FROM:

Distribution authorized to U.S. Gov't. agencies only; Test and Evaluation; APR 1975. Other requests shall be referred to Air Force Rome Air Development Center, IRRC, Griffiss AFB, NY 13441.

AUTHORITY

radc usaf ltr 11 mar 1982

THIS PAGE IS UNCLASSIFIED

AD-B004815

AUTHORITY:

RADC USAF

1tr 11 Mar 82



ADB004815

RADC-TR-74-257, Volume II (of two)
Final Technical Report
April 1975

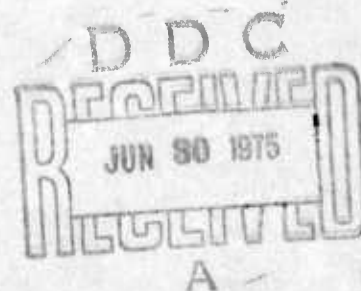


COMPASS PREVIEW DESIGN STUDY
Specifications

Northrop Corporation

Distribution limited to U. S. Gov't agencies only;
test and evaluation; April 1975. Other requests
for this document must be referred to RADC (IRRC),
Griffiss AFB NY 13441.

Rome Air Development Center
Air Force Systems Command
Griffiss Air Force Base, New York 13441



This report has been reviewed and is approved for publication.

APPROVED:

Ronald Klotz

RONALD P. KLOTZ, LT, USAF
Project Engineer

APPROVED:

Howard Davis

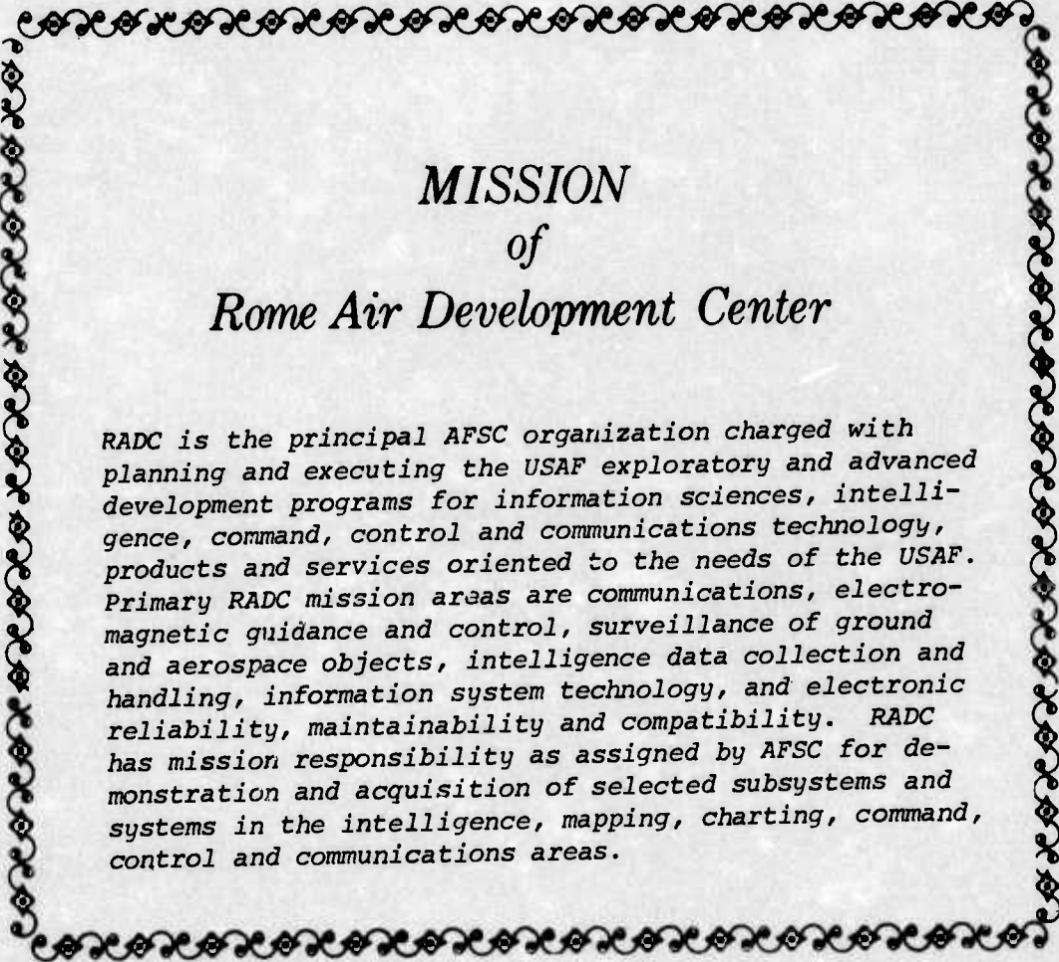
HOWARD DAVIS
Technical Director
Intelligence & Reconnaissance Division

FOR THE COMMANDER:

John P. Huss

JOHN P. HUSS
Acting Chief, Plans Office

Do not return this copy. Retain or destroy.



*MISSION
of
Rome Air Development Center*

RADC is the principal AFSC organization charged with planning and executing the USAF exploratory and advanced development programs for information sciences, intelligence, command, control and communications technology, products and services oriented to the needs of the USAF. Primary RADC mission areas are communications, electromagnetic guidance and control, surveillance of ground and aerospace objects, intelligence data collection and handling, information system technology, and electronic reliability, maintainability and compatibility. RADC has mission responsibility as assigned by AFSC for demonstration and acquisition of selected subsystems and systems in the intelligence, mapping, charting, command, control and communications areas.

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER RADC-TR-74-257, Volume II (of two)	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) COMPASS PREVIEW DESIGN STUDY Vol II - Specifications		5. TYPE OF REPORT & PERIOD COVERED Final Technical Report June 1973 - January 1974
7. AUTHOR(s) Larry C. Toops Robert Redwitz William G. Baker		6. PERFORMING ORG. REPORT NUMBER NORT 74-221B
9. PERFORMING ORGANIZATION NAME AND ADDRESS Northrop Corporation Electronics Division Palos Verdes Peninsula CA 90274		8. CONTRACT OR GRANT NUMBER(s) F30602-73-C-0289
11. CONTROLLING OFFICE NAME AND ADDRESS Rome Air Development Center (IRRC) Griffiss AFB NY 13441		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS 63715F 118102C7
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office) Same		12. REPORT DATE April 1975
		13. NUMBER OF PAGES 115
		15. SECURITY CLASS. (of this report) UNCLASSIFIED
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE N/A
16. DISTRIBUTION STATEMENT (of this Report) Distribution limited to U. S. Gov't agencies only; test and evaluation; April 1975. Other requests for this document must be referred to RADC (IRRC) Griffiss AFB NY 13441.		
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report) Same		
18. SUPPLEMENTARY NOTES RADC Project Engineer: Ronald Klotz, LT, USAF AC 315 330-2344		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number)		
Alphanumerics	Film Transport	Mensurate
Comparison Viewing	Graphics	Modular
Data Base	Hard copy	Monocular
Data Link	Imagery	Photo Data Base
Digital Image	Lineal Dimensions	Readout
		Retrieval
		Stereo
		Target Locations
		Viewer
		Zoom Lens
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This volume consists of a system specification, five module specifications, and one zoom lens specification. These specifications reflect the Compass Preview design as of January 1974; however, the specifications will require further refinement, modification and updating as the detailed design progresses.		

PREFACE

This program was initiated by Rome Air Development Center, Griffiss AFB NY. The design study reported herein was performed by the Electronics Division, Northrop Corporation, 1 Research Park, Palos Verdes Peninsula, California, and Northrop's subcontractor, Redwitz Research, Inc., of Irvine, California, under Contract F30602-73-C-0289. The program manager/project engineer for the design study was Mr. L. C. Toops. The contract monitor for Rome Air Development Center was Mr. Arnold Lanckton (IRRC). The study was started in June 1973 and completed in January 1974; however, significant advancements in the design concept have occurred since then, notably in the areas of

- . Low magnification viewing.
- . Projection annotation of digital image.

These concepts will be investigated further and reported on in the next program phase.

CONTENTS

<u>Section</u>		<u>Page</u>
1	Introduction	1-1 to 1-2
2	Compass Preview System Specification	2-1 to 2-39
3	Specification for a Zoom Projection Module for Compass Preview	3-1 to 3-12
4	Specification for a Digital Image Camera Module for Compass Preview	4-1 to 4-12
5	Specification for a Digital Image Viewer Module for Compass Preview	5-1 to 5-13
6	Specification for an Alphanumerics and Graphics Module for Compass Preview	6-1 to 6-21
7	Specification for a Film Transport Module for Compass Preview	7-1 to 7-13
8	Specification for 5X to 100X Zoom Projection Lens for Compass Preview	8-1 to 8-3

PRECEDING PAGE BLANK-NOT FILMED

SECTION 1

INTRODUCTION

This volume consists of a system specification (Figure 1), five module specifications, and one zoom lens specification. These specifications reflect the Compass Preview design as of January 1974; however, the specifications will require further refinement, modification and updating as the detail design progresses.

Volume I presents the rationale behind the design, and a description of the design and study effort to date that provided the basis for the development of these specifications.

Section 2
COMPASS PREVIEW
SYSTEM SPECIFICATION

1.0 SCOPE

This specification establishes the system-level performance requirements for an engineering model of Compass Preview. Compass Preview will be used, in conjunction with an on-line, integrated, all-source installation data base, to derive intelligence information from photographic transparencies and data link-transmitted imagery.

2.0 APPLICABLE DOCUMENTS

The following documents, of the issue in effect on the date of the request for proposal, form a part of this specification to the extent specified herein.

2.1 Military Specifications

MIL-C-45662	Calibration System Requirements
MIL-E-4158	Electronic Equipment, Ground
MIL-P-116	Preservation, Methods of

2.2 Standards

2.2.1 Military

MIL-STD-130	Identification Marking of U.S. Military Property
MIL-STD-150	Military Standard, Photographic Lenses
MIL-STD-195	Marking for Connection of Electrical Assemblies
MIL-STD-545	Standard General Requirement for Electronic Equipment
MIL-STD-461	Electromagnetic Interference Characteristics, Requirements for Equipment
MIL-STD-721	Definitions of Effectiveness Terms for Reliability, Maintainability, Human Factors, and Safety
MIL-STD-785	Requirements for Reliability Program
MIL-STD-810	Environmental Test Methods
MIL-STD-882	System Safety Program
MIL-STD-1472	Human Engineering Design Criteria for Military Systems, Equipments and Facilities

2.2.2	<u>Federal</u>
FED-STD-102	Preservation, Packaging, and Packing
2.2.3	<u>Other</u>
AFM-66-1	Maintenance Management
MIL-HDBK-472	Maintainability Prediction
2.3	<u>DIA Documents</u>
DIAM 57-1	General Intelligence Production (Confidential)
DIAM 57-4	Coordination, Production and Maintenance of Imagery Interpretation Keys (Confidential)
DIAM 57-5	DOD Exploitation of Multi Sensor Imagery (Secret)
DIAM 57-5A	Format for First and Second Phase Reporting IPIR/SUPIR (Official Use Only)
DIAM 57-5-1	DOD Exploitation of Multi Sensor Imagery, Specific Responsibilities (Top Secret)
DIA AP-560-1-68-INT	Point Reference Guide Book (Secret)
DIAM 65-10-2	Imagery Interpretation Reporting Systems DOD Data Base of Imagery Derived Information Master Imagery Exchange Format (MIEF) (Secret)
DIAM 57-11	Processing and Production of DOD Order of Battle Intelligence (Secret)
DIA 560-4-71	INT Target Intelligence Handbook (Secret)
2.4	<u>Other Publications</u>
AFM 161-8	Laser Health Hazards Control
Program Assisted Console Evaluation Review (PACER) System Description Volume I (Unclassified) and Volume II (Secret)	

3.0 OPERATIONAL EMPLOYMENT

Compass Preview is a new image-handling device designed to operate in conjunction with an on-line integrated installation data base. The initial device will be a prototype (engineering model) that can be modified on-site, so that the entire concept can be honed into an intricate electronic data processing and imaging system that is designed specifically to support the unique decision capability of a photo interpreter or analyst.

Compass Preview shall support the aerospace force planning and operations conducted at a Continental United States (CONUS) base during a peacetime environment. Compass Preview must also support tactical and strategic commands operating in accordance with contingency, war and post-hostility plans that are in concert with the reconnaissance imagery exploitation and intelligence production operations as specified in the National Tasking Plan and (TS) Supplement to DIA 57-5.

3.1 General Operational Parameters - The Compass Preview Prototype employment concepts dictate the following general operational parameters:

- (a) Compass Preview shall be capable of 1) operating in a permanent facility (SAC/544ARTW, Offutt AFB), and 2) being integrated gracefully into other operational environments.
- (b) The equipment shall be modular, for the following reasons:
 - Accommodate Changes In
 - Technology
 - Operational Requirements
 - Permit
 - System Integration
 - System Growth
 - Use in Broad Intelligence Applications
- (c) The reliability of the equipment shall be sufficient to insure a high probability of completion of a given mission.

3.2 Functional Performance - Compass Preview, supported by an installation data base, shall be capable of helping the analyst perform many basic image interpretation, image analysis, and related functions. Each function is necessary to the operation of an effective, modular, comprehensive exploitation system that will fully accommodate current and future reconnaissance collection systems. Some of these functions that Compass Preview shall perform are:

- (a) Installation scanning
- (b) Detailed installation analysis
- (c) Searching for new installations
- (d) Real time digital imagery reception
- (e) Photographic data base retrieval
- (f) Imagery reproduction
- (g) Mensuration
- (h) Exploitation management

3.2.1 Installation Scanning - The scanning function represents those tasks necessary to accomplish initial detection, identification and examination of priority installations; determine the usable coverage in each flight line of the mission; and prepare interpretation reports. The actions involved in accomplishing these tasks are: receive and load mission imagery in the film transport module, and retrieve host computer-prepared mission data for the system processor. Compass Preview shall then sequence the displays of photographic and digital images for viewing imagery, as well as display the reporting format, reporting requirements, and previous reports, in accordance with current intelligence directives.

3.2.2 Detailed Installation Analysis - Compass Preview will be used by category specialists to accomplish rapid detailed analysis of priority installations. Detailed analysis requires flexible manipulation of the imagery that shall include the following: automatic positioning and display of the highest priority installation in a selected category, stereo viewing (both with stationary imagery and while scanning), image rotation and translation, image rectification, image enhancement, mensuration, automatic retrieval of data base imagery for comparison viewing, image annotation, and reproduction of selected displays. Display overlays shall be generated to assist interpretation and analysis, and reporting aids shall be provided.

3.2.3 Searching for New Installations - After completing examination of priority installations, the analysts/interpreters are to detect, identify, locate and report on installations and/or activities (intelligence indicators) whose existence was not previously known. To aid the analyst in performing this function, Compass Preview shall automatically plot known installations and installation cues coincident with imagery. It shall also cause the imagery to be scanned in a pre-established pattern or in a desired direction so as to maximize the probability of detection.

3.2.4 Real-Time Digital Imagery Reception - Compass Preview shall receive all forms of imagery transmitted via high bandwidth communication links, and format this imagery for viewing.

3.2.5 Photographic Data Base Retrieval - Analysts/interpreters are responsible for maintaining a current photographic data base consisting of historical comparison imagery of all installations and special activity areas, and interpretation keys. Compass Preview shall provide automated assistance to the analyst in maintaining this data base in the form of helping him select "best look" imagery, by cutting and annotating the chip, and by automatically updating the digitally addressed data base index.

3.2.6 Image Reproduction - Compass Preview shall provide remote imagery displays and high quality, hard copy, annotated or un-annotated transparencies in a rapid and efficient manner. The hard copy that is produced will be used both for data base updating and the production of briefing aids.

3.2.7 Mensuration - Analysts are responsible for measuring distances, making area and volume estimates of various objects, and determining the geographic coordinates of new installations. Compass Preview shall permit the analyst to rapidly position reticles on the appropriate image locations. The system processor shall then perform the necessary photogrammetric calculations to obtain the desired results.

3.2.8 Exploitation Management - This function entails the establishment of task priorities based upon current intelligence directives. The actions involved in accomplishing this function shall be: compare the mission coverage data with the current reconnaissance objectives in order to select optimum search parameters; determine the highest quality frames covering installations; assign installation search tasks by installation category for detailed imagery analysis and reporting; and continually alter the above tasks as the mission coverage is being exploited so as to maximize responsiveness and utilization of resources.

Compass Preview shall also provide for rapid call-up of interpretation reports by supervision to assist him in report review and validation.

4.0 REQUIREMENTS

Compass Preview shall be the image handling component used to derive timely intelligence from reconnaissance imagery. The other two components are: 1) the operator and his ability to make intelligent decisions and interpret images, and 2) an on-line electronic data processor with its all-source integrated installation data base.

4.1 System Requirements - Compass Preview shall be a reconnaissance imagery viewer that automates many of the heretofore manual image handling tasks, so that an operator can spend most of his time making decisions and performing image analysis. Compass Preview shall accept the following as inputs: both photographic and digital imagery (either as negatives or positives), mission data, reporting requirements, previous reports, and appropriate segments of the installation data base. Compass Preview shall provide as outputs: 1) installation intelligence, and 2) selected image segments appropriately annotated for use either as an historical data base record or as briefing aids. Compass Preview shall support scanning and 1st, 2nd, and 3rd phase reporting.

4.1.1 System Performance - Compass Preview shall have the following general performance capabilities:

4.1.1.1 Automated positioning and scaling of photographic imagery.

4.1.1.2 Rectification and enhancement of digital imagery.

4.1.1.3 Both monocular and stereoscopic modes of display.

4.1.1.4 Interpretation assistance in the form of automatically displaying appropriate alpha-numeric, graphic, and grid data coincident with imagery.

4.1.1.5 Readout of image position.

4.1.1.6 Automatic correlation of the displayed image with appropriate references (e.g., map, chips and previous reports, based on geographic position, or B. E. No.).

4.1.1.7 Flexibility in permitting the operator to select a mode of comparing previous imagery with present imagery. Side-by-side display, coincident image flickering, and image rectification shall be provided to facilitate comparison viewing.

4.1.1.8 Flexibility in permitting the operator to make accurate determinations of location, azimuth, distance, height, area, and volume.

4.1.1.9 Flexibility in permitting the operator to format, annotate, and prepare imagery either as an historical record (data base) or as a briefing aid.

4.1.2 System Inputs - Compass Preview shall accept the following inputs:

4.1.2.1 Imagery - It shall be possible to exploit both photographic film images and digital images.

4.1.2.1.1 Photographic Film Image - The photographic film image input can either be cut or roll film, on standard film bases. This input can consist of either monocular or stereo coverage.

4.1.2.1.2 Digital Image - The digital image input has a digital value for photographic density. The ordered sequences of digital values relate to the density value of the image at a given position. Digital imagery is normally received over a wide-band communications link. It can consist of either monocular or stereo coverage.

4.1.2.2 Intelligence Data - The intelligence data input comes from the on-line installation data base.

4.1.2.3 Manual Input - Manual inputs are in the form of reticles, data pens, keyboards, control panels, track balls, and other interactive devices.

4.1.3 System Processing - Compass Preview shall perform the following processes:

4.1.3.1 Analysis of imagery in accordance with the following parameters:

4.1.3.1.1 Exploitation Priority

4.1.3.1.2 Installation Category

4.1.3.1.3 Geographic Area

4.1.3.1.4 Mission Coverage

4.1.3.2 Extraction of the data to answer the basic E.E.I.'s (Essential Elements of Information).

4.1.3.3 Processing of Work Orders

4.1.3.4 Searching for New Installations

4.1.4 System Outputs - Compass Preview shall provide the following outputs:

4.1.4.1 Imagery - Two distinct forms of imagery, i.e., photographic images and digital images.

4.1.4.1.1 Photographic Image - The photographic image output is a film transparency.

4.1.4.1.2 Digital Image - The digital image output is made available for recording and/or transmitting by various communications links.

4.1.4.2 Image Derived Intelligence - Image derived intelligence is derived as a result of Compass Preview processing (as opposed to the intelligence developed by the operator). It shall consist of:

4.1.4.2.1 Display - Imagery displayed to the operator.

4.1.4.2.2 Relay - Data formatted for input into the installation data base as image-derived intelligence (e.g., coordinates, measurements, etc.).

4.1.5 Physical Characteristics

4.1.5.1 Size - Any single module or unit of Compass Preview shall be capable of being transported through a 36" wide x 80" high door.

4.1.5.2 Electrical Power - Compass Preview shall operate with commercial connectors from an electrical power source of 115 and 208 volts a.c., 1 or 3 phase. Power consumption shall be less than 5000 watts.

4.1.5.3 Cooling - Compass Preview shall have a positive, filtered air cleaning and convective cooling system.

4.1.6 System Interface - Compass Preview shall have the following interfaces:

4.1.6.1 Installation Data Base - Hardware and software interfaces to the PACER system.

4.1.6.2 Digital Imagery - Communication links shall be interfaced so as to permit both transmission and reception of digital imagery.

4.1.7 System Design and Fabrication - Compass Preview shall be fabricated in accordance with standard commercial engineering practices. Where possible, off-the-shelf components shall be used.

Compass Preview shall be of modular design. This approach permits easy change or updating of various modules as they become outdated or as technology improves, thereby continuously improving the overall function and implementation of Compass Preview. The modularity of Compass Preview is also necessary since this is a new image exploitation device operating with an on-line intelligence data base and many of the functions and capabilities currently envisioned may not be required, and many new functions and capabilities may evolve.

4.1.7.1 Materials and Parts - The selection and application of parts, materials, and processes, wherever practical, shall be in accordance with MIL-E-4158.

4.1.7.1.1 Materials - Fungus nutrient materials shall not be utilized wherever practical, and materials which support volatile combustion shall not be used. Hygroscopic materials, such as cotton, shall not be used for electrical insulation, and materials which are capable of producing dangerous gasses or other harmful toxic effects under any condition shall not be used.

4.1.7.1.2 Parts - All parts shall be designed and fabricated in accordance with good commercial practices. Requirements include, but are not limited to:

4.7.1.1.2.1 Marking - Each part used in constructing and assembling the equipment shall be marked in accordance with good commercial practice. Connectors for electrical assemblies shall be marked wherever practical in accordance with MIL-STD-195.

4.1.7.1.2.2 Standardize - Maximum use, commensurate with overall design requirements and cost, shall be made of qualified parts and standard parts. The variety of types and sizes of parts shall be held to a minimum. Parts with established reliability levels shall be given preference.

4.1.7.1.2.3 Metal Corrosion - Design and construction shall ensure that, wherever practical, metal parts are resistant to corrosion. The use of dissimilar metals in immediate contact, which may result in electrolytic corrosion in the presence of vapor or moisture, shall be avoided.

4.1.7.2 Electromagnetic Radiation

4.1.7.2.1 Equipment - Equipment shall comply with the radiation requirements of MIL-STD-416, wherever practical.

4.1.7.2.1.1 Cables - All cables shall be designed to restrict radiation of the signals being conducted by the cable to the lowest practical level. The cable assembly shall be of a fully integrated design which includes connectors and bonding provisions as required to maintain shielding efficiency in an actual operational situation/installation.

4.1.7.2.1.2 Cable Shields - Cables shall incorporate an outside shield that completely covers the conductors and lines that comprise the cable. The overall shield shall provide the maximum shielding practical and may consist of a combination of woven or braided materials combined with a flexible conduit. The shield shall be protected by a suitable abrasion resistant insulating jacket.

4.1.7.2.1.3 Laser Radiation - Wherever coherent laser sources are used, the requirements of AFM 161-8 and MIL-STD-882 shall be followed.

4.1.7.3 Interchangeability - All prime items and associated parts having the same manufacturer's part number shall be, wherever practicable, interchangeable directly and completely with respect to installation and performance.

4.1.7.4 Safety - Provisions shall be made to promote the maximum safety of all personnel and equipment during installation, operation, and maintenance of Compass Preview, with emphasis on laser hazards as specified in MIL-STD-882 and AFM 181.

4.1.7.5 Human Performance/Human Engineering - Human engineering principles shall be applied in the design of Compass Preview to ensure that adequate consideration is given to man's capabilities and limitations in order that the man-machine combination that is most usable, reliable, safe and efficient, is achieved. Human engineering shall be considered in the design of each module to maintain and increase the human's effectiveness during operation, control and maintenance. The information presentation equipment (displays), and the selection and placement of operational controls and indicators shall reflect sound human engineering. The provisions of MIL-STD-1472 shall be considered wherever practical.

4.1.8 System Operation

4.1.8.1 Operating Environment - Compass Preview shall be capable of operating within the following limits:

4.1.8.1.1 Operational Range - Compass Preview shall be designed to start at temperatures from +50°F to +125°F, and will operate from +60°F to +105°F.

4.1.8.1.2 High Temperature - Compass Preview shall be designed to withstand storage temperatures of +160°F.

4.1.8.1.3 Low Temperature - Compass Preview shall be designed to withstand low storage temperatures of -80°F.

4.1.8.1.4 Humidity - Compass Preview shall be designed to withstand up to 50% relative humidity at a temperature of +75°F.

4.1.8.1.5 Vibration - When Compass Preview or its assemblies are protected by shock or vibration mounts, the mounts shall have a natural frequency of 25 ± 2 cps and shall attenuate all frequencies above 32 cps. In addition, they shall be capable of being removed or shorted out, without disassembly. To ensure that Compass Preview shall withstand the low frequency vibration associated with ground vehicles, and shipment by common carrier, Compass Preview shall not have any natural frequencies below 55 cps. Exception to the 55 cps may be made for glass panes, mirrors, and other large optical elements. In these instances, provisions shall be made to support them as required to withstand the dynamic environment levels required above.

4.1.8.1.6 Pressure - Compass Preview, as a design goal, shall be designed to withstand the following pressure conditions:

4.1.8.1.6.1 Operating - Sea level to 10,000 feet.

4.1.8.1.6.2 Storage - Sea level to 50,000 feet.

4.1.8.2 Operating Personnel - The major objective of Compass Preview is to permit the operator to derive the needed intelligence from imagery in the most efficient and timely manner. That is, Compass Preview shall provide a trained operator with all of the necessary aids or tools to perform his interpretative tasks as efficiently as practicable.

4.1.8.2.1 Operator Qualifications - Qualifications of the operator shall be possession of AFSC 8044, 20670 or 20650, and three years of on-the-job experience.

4.1.8.2.2 Operator Training - Compass Preview shall be operable by an operator, with the qualifications specified in 4.1.8.2.1, after he has completed a two-week training course on Compass Preview within the operational facility.

4.2 Module Requirements - Compass Preview shall be developed with current state-of-the-art so as to be fully operational in 5 to 10 years. To ensure that the best possible technology is used in an operational Compass Preview, a modular system concept shall be pursued. The modularity in this system is in fact being over-emphasized, so that major modules or sub-modules may be easily exchanged during the subsequent development, test, and evaluation of the system in an operating environment. The modules that make up a Compass Preview System are shown in the spec tree presented in figure 1.

4.2.1 Internal Modules - Compass Preview shall consist of the following major modules that shall be contained within the Compass Preview viewer and digital image enclosures and electronics rack.

4.2.1.1 Film Transport Module - The film transport module shall quickly and accurately position the film in response to commands from the system processor.

4.2.1.1.1 Inputs - The inputs that this module shall accommodate are:

- (a) Illumination Module - This module shall illuminate the film in the film gate.
- (b) System Processor - The system processor shall provide position, rate, and direction translation commands, and occluder state and rotation commands.
- (c) Control Panel - The control panel shall provide manual mode selection and control of the film transport.
- (d) Photographic Film - The film transport shall accommodate all films with the following characteristics:
 - (1) Film Widths - 35mm, 70mm, 5 inch, 6.6 inch and 9-1/2 inch roll film, and cut film up to 4-3/4" x 7-1/2".
 - (2) Film Thicknesses - Base thicknesses of 1.5 to 5.2 mils (this does not include emulsion, gel backing, and other film coatings).
 - (3) Film Roll Capacity - The nominal film roll capacity shall be a minimum of 500 feet of 5.2 mil film.
 - (4) Base Materials - Both acetate and polyester bases shall be accommodated.

(5) Film Spools - The film spools that are employed shall be as follows:

- RRC 721410-1 for film widths from 35 mm to 5.0 in. wide
- RRC 721410-3 for film widths from 5.1 in. to 7.0 in. wide
- RRC 721410-5 for film widths from 7.1 in. to 9.5 in. wide

4.2.1.1.2 Processing - The film transport module shall accomplish the following processing:

- (a) Roll Film Translation - The film transport shall provide the following bi-directional speed ranges for roll film translation along the film length:
- (1) Rewind - for widths to 7.0 in.: 100 in./sec min.
 - (2) Rewind - for widths above 7.0: 75 in./sec minimum.
 - (3) Fast Forward/Reverse - Computer Control - 3 ranges consisting of 10, 50, and 100 in./sec.
 - (4) Fast Forward/Reverse - Manual Control - Variable from 1.5 to 100 in./sec < 7.0 in. wide
1.5 to 75 in./sec > 7.0 in. wide
 - (5) Incremental - Computer and Manual Control - Variable from 0.001 to 5.000 in./sec.
- (b) Chip Positioning - Positioning of the chip in the 7-1/2" dimension shall be manually controlled at a variable selectable rate, from 0.001 to 5.000 in/sec. It shall be possible to control the positioning of a chip anywhere within a 7-1/2" length.
- (c) Transverse Positioning Speed - Transverse positioning of the transport shall be provided. The positioning shall also move the roll film or chip in the direction of its width. This positioning shall be under either computer or manual control, at a variable selectable rate from 0.001 to 5.000 in/sec. Positioning shall be possible anywhere across an entire 9-1/2" wide roll film or a 4-3/4" wide film chip.

- (d) Stopping and Image Positioning - The capability of rapidly stopping at any predetermined location on roll film shall be provided. No creep shall occur after a stop. The final positioning of the image in the center of the film gate (which shall coincide with the optical axis) shall be accomplished in at least 5 seconds after the edge of frame has been located. Positioning shall be accomplished with a precision of ± 0.1 inch of actual commanded location.
- (e) Frame Detection - The transport shall have a capability to detect the edge of a frame of imagery when operating in either direction.
- (f) Film Tensioning - The film transport shall be equipped with a positive control that enables the operator to select film tension equal to 80 PSI ± 20 PSI stress for all film widths, thicknesses, and base materials.
- (g) Chip Loading - Automatic transverse positioning of the transport, for both chip loading and chip display, shall be provided.
- (h) Occluder - An occluder shall be provided to mask one-half of the roll or chip film gate, for comparison viewing purposes. A design goal shall be a capability to rotate this occluder in synchronism with the image rotation prism of the zoom projection module.

4.2.1.1.3

Outputs - The outputs that this module shall provide are:

- (a) Zoom Projection Module - The interface between the film transport module and the zoom projection module shall be via a roll film gate and a chip film gate.
 - (1) Roll Film Gate - The roll film gate shall perform the final incremental adjustment to the film plane, thereby insuring sharp, uniform focus over the entire format. The film gate shall employ air to push the film away from the gate during high speed translation. However, during low speed scanning and when the film is stopped for detailed examination, the flow of air shall be reversed and the film shall be clamped to the edges of the gate.

The film gate shall be a clear aperture in a horizontal plane of at least 4.5 in. x 9.0 in. No glass platens or other double-sided constraint devices shall be used to provide the following film flatness values over the following areas:

±.001 in. (0.025 mm) over 0.28 in. (7 mm) dia.

±.010 in. (0.25 mm) over 1.25 in. (32 mm) dia.

±.080 in. (2.00 mm) over 4.50 in. (114 mm) dia. and up

- (2) Chip Film Gate - It shall be possible to easily and rapidly load two 4-3/4" x 7-1/2" chips in one chip film gate. Glass platens may be used to make the chip film gate. The chip film gate shall provide the flatness values specified in (a)(1) above.

- (b) System Processor Module - System Processor feedback signals shall be provided for the following:

- Search Mode
 - Frame Count
 - Spool Revolution Count
 - End-of-Film Indication
- Incremental Mode
 - Direction
 - Steps (.001 in./step) from "0" Ref.
 - Transverse Direction Steps (.001 in./step)
- Broken Film (Loss of Tension)
- Occluder State and Rotation

4.2.1.1.4

Design and Construction

- (a) Overall Design Concept - The film transport shall employ an advanced concept in film handling that minimizes contact and subsequent film damage. The film path shall be a single straight line from the supply spool to the take-up spool. The Film Transport Module shall handle and transport film from spool to spool at designated speeds without requiring any physical contact with either guiding or film sensing devices. The only contact the film shall be subjected to is film-on-film (as in winding on spool) and contact with film spool flanges with one edge only. No double-sided constraining

of film shall be used at any point of the film between the tangent points of the film spools. (No guide rollers shall be used.) The film between the spools that forms the image plane shall be kept at the same location in space regardless of the amount of film that remains on the spools, by moving the spools independent of the rest of the transport, using commands from a film plane position detector.

(b) Types of Transports - Two types of transports shall be provided that are identical in all respects except that one type will, and one type will not, have a film chip capability; and the type without a film chip capability must operate inverted.

(c) Physical Dimensions - Physical dimensions of the Film Transport Module shall be as follows:

- Film Transport Assembly - 37 inches long x 33 inches wide x 15 inches high
- Power and Control Electronics - 24 inches long x 24 inches wide x 20 inches high

(d) Interfaces

(1) Mechanical Interface - The Film Transport Module shall conform to the envelope size and shall be equipped with mounting provisions compatible with the overall system.

(2) Electrical Interface - The Film Transport Module shall be capable of receiving and executing the following command signals:

- High Speed Mode

- Direction - OV (FWD) or +5 V DC (REV)
 - 10 in./sec
 - 50 in./sec
 - 100 in./sec
- } +5 V DC (Discrete)

- Incremental Mode

- Direction - OV (FWD) or +5 V DC (REV)
- Run/Standby Command - 0 or 1
- Clock Pulse - 200 to 5000 Pulses per Second

- Rewind Mode

- Direction - +5 V DC
- Velocity - +5 V DC

(3) Optical Interface - See 4.2.1.1.3(a)

- (e) Power Consumption - The power consumption of the Film Transport Module shall not exceed 750 watts.
- (f) Film Loading - The loading of roll film onto the film transport module shall take no more than 30 seconds and shall be as easy as practical.

4.2.1.2 Illumination Module - The illumination module shall provide illumination through the film, projection lenses, and mirrors so that a Photo Interpreter perceives a uniformly illuminated field with a minimum brightness level of 15 foot-lamberts through a film of 3% transmittance (i.e., the dark areas of the film).

The illumination module shall also provide illumination to the hard copy module and the digital image camera module.

4.2.1.2.1 Inputs - The inputs to this module are shutter and illumination commands from the system processor.

4.2.1.2.2 Processing

- (a) Source Brightness - The following source brightness shall be supplied by the illumination module:

Zoom Projection Module		Required Source Brightness, Candles/MM ²
Magnification	F Number	
100	2.56	20.42
50	4.5	18.48
25	8.4	17.32
10	19.5	15.62
5	37.0	14.39

- (b) Uniformity - The illumination shall be uniform within 67% throughout the field of view, for all values of zoom projection module magnification.
- (c) Illumination Switching - A capability shall be provided to switch the illumination sideways a discrete amount equal to the separation of the zoom lens optical axes, in order to effect stereo reversal (i.e., cancellation of pseudo stereo).

- (d) Illumination Shuttering - It shall be possible to shutter a given illuminator when it is not in use. An operator-variable control of the shutter rate, to effect flicker, shall also be provided. This rate shall be continuously variable from 1 cycle every 2 seconds to 10 cycles per second.
- (e) Illumination Level Control - It shall be possible to control the level of the illumination without affecting its color temperature, either manually or automatically, with the aid of the system processor. Automatic control shall be accurate to within $\pm 15\%$ of a commanded value, preferably as measured at the output of the zoom projection module. Control shall be effective continuously over the range to provide 2 ft. candles illumination at the digital image camera, to the maximum specified in 4.2.1.2.
- (f) Color - The illumination color shall be white.

4.2.1.2.3 Outputs - The outputs from this module are:

- Light level to the system processor
- Illumination to any and all of the film transport film gates, the zoom projection module, the low magnification module, the hard copy module, and the digital image camera lens

4.2.1.2.4 Design and Construction

- (a) Power Consumption - No more than 350 watts of power shall be consumed by this module.
- (b) Lamp Sharing - A design goal shall be to share a common lamp between two illumination modules. (Both modules need not supply light simultaneously.)

4.2.1.3 Zoom Projection Module - The function of the zoom projection module shall be to vary image scale and orientation of photographic transparencies. A single projection module shall be used to project a two-dimensional (mono) image. Two projection modules shall be used for projecting three-dimensional (stereo) images. At the operator's discretion, the projected images shall either be displayed on the viewing module, or imaged on the targets of the digital image cameras, via the digital image camera lenses, or imaged on the hard copy module.

4.2.1.3.1
the following:

Inputs - The inputs to the zoom projection module are

- (a) Illumination Module - The position, excursion, and size of the entrance pupil shall be as defined by the requirements shown on the specification control drawing.
- (b) Film Transport Module - The nominal distance from the vertex of the lens nearest the film plane, to the film plane itself (film gate) shall be 12.00 ± 0.5 inches. The Projection Module shall be capable of accommodating changes in the film plane by having an internal focus adjustment of ± 0.03 inches.
- (c) Low Magnification Adapter Module - If a low magnification adapter lens is provided, it will permit the zoom projection module to image a 9-1/2" x 9-1/2" field of view at low magnification (2X or less).
- (d) System Processor Module - The illumination module shall respond to the following commands from the system processor module:
 - Magnification Increase
 - Magnification Decrease
 - Image Rotation - Clockwise
 - Image Rotation - Counterclockwise
 - Flip Mirror - Up
 - Flip Mirror - Down

4.2.1.3.2

Processing

- (a) Image Scaling - The Projection Module shall be capable of providing continuously variable magnification from 5X to 100X.
- (b) Image Rotation - The Projection Module shall contain a device for optically rotating the image within an accuracy of $\pm 0.1^\circ$. The device shall be actuated by an electric motor which responds to position commands. A device to provide a position feedback signal shall be incorporated.
- (c) Resolution - The Projection Module shall exhibit the below stated polychromatic resolution when using a high-contrast (1000:1) Standard Air Force resolution test target containing test patterns, including the group 9-6. The resolution shall be measured in the aerial image.

<u>Position</u>	<u>Line Pairs/MM/Power</u>
Axial	5
11" Off-Axis	4

- (d) Focus Shift - The Projection Module shall not require refocusing to meet the foregoing resolution requirements.
- (e) Time for Zoom - The Projection Module shall be capable of covering the complete magnification range in not more than 6 seconds.
- (f) Field of View - The Projection Module shall cover a field of view not less than 4.5 inches at the 5X position.
- (g) Projected Image Size - The projected image shall not be less than $22.5 \pm .5$ inches in diameter at the lowest magnification.
- (h) Light Transmission - The Projection Module shall be capable of transmitting at least 65% of the illumination.
- (i) Distortion - The Projection Module shall exhibit no more than 5% radial distortion at any magnification.
- (j) Interpupillary Adjustment - If an interpupillary adjustment is required, it shall be provided for by the projection module.

4.2.1.3.3 Outputs - The outputs of the zoom projection module shall include the following:

- (a) Digital Image Camera Lens - The Projection Module shall be equipped with a pellicle beam splitter that permits 5 foot candles of illumination from the projection lens to be diverted to the Digital Image camera lens, with 3% transmittance film in the film gate.
- (b) Hard Copy Module - This output shall be identical to (c), except that an additional fold shall be made in the optical path to direct the image to the hard copy module instead of to the viewing module.

- (c) Viewing Module - The Projection Module shall have a nominal projection path length of 77.0 ± 2 inches measured from the vertex of the lens nearest to the viewing surface to the viewing surface itself. The exit pupil shall be located at a nominal distance of 83.5 inches from the viewing surface. The exit pupil location shall not vary more than ± 2.0 inches during the full zoom travel. The diameter of the exit pupil shall be constrained to be between 0.3 and 0.5 inch for all magnifications.
- (d) System Processor - The Projection Module shall provide feedback signals which indicate the following:
 - Zoom Position (Magnification)
 - Image Rotation (Relative to Film)
 - Flip Mirror Position (Up-Down)

4.2.1.3.4 Design and Construction - Zoom projection module design and construction shall conform to figure 3-23, Vol. I.

4.2.1.4 Viewing Module - The viewing module shall display either a roll or chip film or digital image to the analyst, either monocularly or stereoscopically. It shall be possible to project alphanumerics and graphics coincident with these images, for annotation purposes. Comparison displays of a roll film image with a roll film or chip image, or of a digital image with a digital image, shall also be provided.

4.2.1.4.1 Inputs - The inputs to the viewing module are as follows:

- (a) Zoom Projection Modules
- (b) Digital Image Viewer Lenses
- (c) Alphanumerics and Graphics Projector Lens
- (d) System Processor Module - Mono, Stereo or Comparison Display Command

4.2.1.4.2 Processing

- (a) Function - The viewing module shall form viewing exit pupils for use by the operator of the images projected via inputs (a), (b), and (c) (paragraph 4.2.1.4.1).
- (b) Resolution - The resolution of the viewing module shall be sufficient to permit observation by an operator of at least 5 line pairs/mm per power in the prime viewing area, for all magnifications of the zoom projection module up to 70X.

4.2.1.4.3

Outputs

(a) Exit Pupils

- (1) The viewing module shall provide two, 2" diameter stereo exit pupils separated by 2.5 inches. $\pm 1\frac{1}{2}$ " of fore and aft head movement shall be provided.
- (2) The viewing module shall provide one, 4-5 inch diameter mono exit pupil from either projection module. ± 2 inches of fore and aft head movement shall be provided.
- (3) The viewing module shall provide, in conjunction with the occluders and zoom projection module, two 4-5 inch exit pupils that overlap at least 3.5 inches, for comparison viewing. ± 2 inches of fore and aft head movement shall be provided.
- (4) The viewing module shall provide, in conjunction with the alphanumeric and graphics projector lens and adjustable mirror, an annotation exit pupil that completely overlaps either stereo exit pupil, the mono exit pupil, or the overlap area of the comparison viewing pupils. ± 2 inches of fore and aft head movement shall be provided for mono, annotations, and ± 1.5 inches shall be provided for stereo annotations.

- (b) Diffuser State - A diffuser state signal shall be sent to the system processor module.

4.2.1.4.4 Design and Construction - The viewing module shall have the following characteristics (see figure 3-13, Vol I).

- (a) Prime Viewing Area - 22.5 inches diameter
- (b) Focal Length - 18 inches
- (c) Relative Aperture Over Prime Area - $f\ 0.8$
- (d) Diagonal of Viewing Area - 28 inches
- (e) Relative Aperture Over Diagonal - $f\ 0.64$
- (f) Nominal Viewing Distance - 23.25 inches
- (g) Viewing Angle - 64 degrees

4.2.1.5

Low Magnification Module

- (a) Field of View - The low magnification module shall permit the operator of a Compass Preview to see both edges of a 6.1 inch wide or less frame, regardless of the film's position with respect to the zoom projection module optical axis. This module shall also permit viewing an entire 9.5 inch film width when centered on the optical projection axis, and a minimum of 6.1 inch of the film width, regardless of the film's transverse position.
- (b) Annotations - A capability to annotate the film with alphanumerics and graphics module equipment shall be provided.
- (c) Hard Copy - A capability to make hard copy reproductions of the annotated low magnification image shall be provided.

4.2.1.6

Reticle Projector Module

- (a) Function - The reticle projector shall be capable of projecting a reticle transparency image onto the viewing module optical axis, for use as a mensuration reference.
- (b) Exit Pupil Size - The exit pupil shall be 4-5 inches in diameter in the mono viewing mode.
- (c) Reticle Changing - Different shaped and sized reticles shall be provided by interchanging transparencies.
- (d) Power Consumption - Power consumption shall be 30 watts or less.

4.2.1.7

Digital Image Camera Lens

- (a) Function - A lens shall be provided to couple the digital image camera to the zoom projection module.
- (b) Magnification - The lens magnification shall be selected so that the digital image, as seen via the digital image viewer and viewing module, can be magnified through the range 20X to 100X.
- (c) Mechanical Interface - See paragraph 3.3.12.2 of the digital image camera module specification.

- (d) Resolution - Resolution shall be sufficient to not degrade the limiting resolution of the digital image camera, as specified in the digital image camera module specification, by more than 10%.

4.2.1.8

Lens for Alphanumerics and Graphics Projector

- (a) Exit Pupil to Viewing Module Distance - The distance between the lens exit pupil and the viewing module shall be 83.25 inches.
- (b) Field Coverage - The lens shall image a field of approximately 5" in diameter
- (c) Projected Field - The lens shall project the covered field to a 27 ± 1 inch diameter at the viewing module.
- (d) F Number - The F number shall be large enough to create a pupil size that overlaps all pupil sizes specified in paragraph 4.2.1.4.
- (e) Associated Mirror - If needed, an adjustable mirror shall be provided for overlapping the annotation pupil with either the left or right eye stereo pupil, at the operator's discretion.
- (f) Distortion - Both radial and tangential distortion shall be less than 2%.
- (g) Resolution - Resolution shall be sufficient to not degrade the limiting resolution of the projector, specified in the alphanumerics and graphics module specification, by more than 5%.

4.2.1.9

Lens for Digital Image Viewing Module

- (a) Exit Pupil to Viewing Module Distance - The distance between the lens exit pupil and the viewing module shall be 83.25 inches.
- (b) Field Coverage - The lens shall image a field of 5-10 inches in diameter (field depends on final CRT diameter selected for digital image viewer).
- (c) Projected Field - The lens shall project the covered field to a 28-inch diameter at the viewing module.
- (d) F Number - The F number shall be selected so as to create pupils as large as, or slightly larger than those specified in paragraph 4.2.1.4.

- (e) Distortion - Both radial and tangential distortion shall be less than 2%.
- (f) Resolution - Resolution shall be sufficient to not degrade the limiting resolution of the digital image viewer, as specified in the digital image viewer module specification, by more than 5%.

4.2.1.10 Digital Image Camera Module - The requirements for this module are specified in the digital image camera module specification.

4.2.1.11 Digital Image Viewer Module - The requirements for this module are specified in the digital image viewer module specification.

4.2.1.12 Alphanumeric and Graphics Module - The requirements for this module are specified in the alphanumeric and graphics module specification.

4.2.1.13 Video Mixer/Switcher Module

- (a) Mixing - A capability to mix annotation video with digital image video shall be provided.
 - (1) Mixing Ratio - It shall be possible to vary the relative intensity of annotations superimposed with digital imagery over a 5:1 or greater range.
 - (2) Bandwidth - The bandwidth of the video mixer shall be at least 40 MHz.
 - (3) Insertion Loss - The video mixer shall have an insertion loss of 3 db or less.
- (b) Switching - This module shall permit the operator to switch any one of seven video inputs to any one of three video outputs. A manual patch panel, using short coax jumpers with twist-lock BNC connectors, shall be used to effect switching.

4.2.1.14 Enclosure Assembly

- (a) Configuration - The enclosure assembly shall conform to the configuration shown in the master layout drawing (figure 3-32, Vol. I). The assembly shall consist of two modules:
 - Digital image enclosure
 - Viewer enclosure

These two modules shall be separable for transit storage. The two enclosures shall be capable of being bolted together in proper alignment at the operational site. It shall be possible to convert a viewer enclosure to a digital image enclosure (for a "stereo digital image only" modular configuration) by placing the two digital image viewers at the film gate locations, and removing film handling and imaging modules.

The viewing module and control console shall be attached to the viewer enclosure by a full length hinge, thereby providing access for film transport loading.

The top of the viewing module shall be tilted away from the operator, and the plane of the viewing module shall be 10-15° from vertical.

The control console shall be sloping as shown in the master layout drawing. This console shall house the controls shown in figure 3-45, Vol. I.

- (b) Vibration - Vibration isolators shall be provided for each enclosure module to permit meeting resolution requirements in the operational environment.
- (c) Cooling - A positive pressure, filtered air supply shall be supplied. Push-pull air flow shall be employed. Localized cooling shall be provided to maintain temperatures specified in individual module specifications. The cooling module shall be mounted external to the enclosures and connected to the enclosures by ducts, in order to minimize induced vibrations in the enclosure from this source.
- (d) Construction - The structure shall be built from square aluminum tubing that will be rigidly reinforced at all corners. Load-bearing diagonal members shall be used to form an extremely rigid and stiff truss. Mountings for the zoom lenses, condensers, and film transports shall be designed to distribute the loads over a large area of the structure. The design of the structure shall eliminate stress concentrations which might cause the precise alignment of the elements to change with time, and shall also eliminate deflection during and after motion of elements such as the film transport. Tooling points shall be provided to permit the rapid establishment of centerlines,

end points, angular relationships, and for periodic alignment checks or in the event major modules are removed or added.

The viewer enclosure shall be mounted on four casters to facilitate movement of the structure. Once in position, the structure will be jacked-up off the casters and shall ride on vibration isolators.

The entire structure shall be enclosed with sheet metal panels. These panels shall, for the most part, be non-load bearing. Quick-release locks shall be provided so as to allow ample access to all portions of the enclosure for servicing. Removable interior baffles shall prevent stray light from reaching unwanted areas and eliminate ghost images or flare. All interior surfaces shall have a flat black finish in order to absorb light.

4.2.1.15 Electronics Rack - The electronics rack shall contain the assemblies shown in figure 3-33, Vol. I. Cooling modules shall be provided to dissipate the heat generated by these assemblies.

The rack shall mount standard 19" relay rack units. Front access, pull-out maintenance shall be possible.

4.2.1.16 Operator's Chair - The operator's chair shall permit the following adjustments:

Height: ± 3 inches

Fore and aft: ± 3 inches

Tilt: $\pm 7^\circ$

4.2.1.17 Hard Copy Module

- (a) Function - The hard copy module shall make a hard copy print or transparency of any imagery and annotations displayed via the viewing module. This hard copy can be used for: producing briefing aids; as a guide to analysts performing precise coordinate determination on other equipment; or as a reference chip in the photo data base.
- (b) Configuration - The hard copy module shall consist of the following:
 - Polaroid roll film back suitable for use with 40 series transparency roll film.

- Two speed solenoid-operated shutter (for use with the automatic light level control system). Speeds shall be 10 \pm 10% milliseconds and 80 \pm 10% milliseconds.
- Lens(es) to image the entire viewing module image onto the film plane.
- Dippit tank to remove processing chemicals and coat the image with a preservative.
- 2 minute timer for timing processing.

4.2.2 External Modules - External modules are those modules that are physically located at a distance from a Compass Preview enclosure. However, they support or enhance the functioning of the overall Compass Preview system. External and internal modules shall have compatible interfaces.

4.2.2.1 System Processor Module

- (a) Function - The system processor shall control other modules and perform logical searches and calculations. It shall also provide the functional interface between the analyst and all other modules and their combined functions, via data entry and variable function keyboards, a data pen, and a control panel.
- (b) Configuration - The system processor module shall consist of the following:

<u>Item</u>	<u>Quantity</u>	<u>Description</u>
1	1	PDP-11/45-FS System Consisting of: <ul style="list-style-type: none"> • Central Processor • 32K Words of Parity Memory • Hardware Memory Management • Line Frequency Clock • Multi-Device Auto Loader • Power Fail/Auto Restart • LA30-CA and Interface
2	1	FP11-B, Floating Point Processor
3	1	KW11-P, Programmable Clock
4	1	RK11-DE, Controller for Eight Disk Drives and First 1.2 Meg Word Drive

5	1	TM11-EA, Controller for 8 Tape Transports and First 9 Track Tape Transport and 72" Cabinet
6	1	TU10-EE, 9 Track Tape Transport and Cabinet
7	2	DD11-B, System Units
8	1	DR11-C, GP Interface
9	1	H960-DA, Cabinet with 21" Expansion Chassis and Power Supplies
10	1 Lot	QJ580-AE, RSX11-D Software

4.2.2.2 Functional Software - Functional software shall be supplied as described in Appendix B, Vol. I.

4.2.2.3 Interface Adapter Module - The circuitry used to interface the alphanumerics and graphics module with the UNIBUS shall be the DR11-B Direct Memory Access Interface; the circuitry used with the viewer enclosure electronics and the photo data base module shall be the DR11-C General Device Interface. (The DR11-B and DR11-C are logic circuit modules (cards) which can be purchased from DEC (Digital Equipment Corp.), the manufacturer of the PDP 11/45. Each logic circuit module represents a unit bus load to the UNIBUS.)

4.2.2.4 Interface Adapter Module - The circuitry used to interface the alphanumerics and graphics module with the UNIBUS shall be the DR11-B Direct Memory Access Interface; the circuitry used with the viewer enclosure electronics and the photo data base module shall be the DR11-C General Device Interface. [The DR11-B and DR11-C are logic circuit modules (cards) which can be purchased from DEC (Digital Equipment Corp.), the manufacturer of the PDP 11/45. Each logic circuit module represents a unit bus load to the UNIBUS.]

The Direct Memory Access Interface shall enable block transfers of data from the system processor memory to the 4K word memory of the alphanumerics and graphics module.

The General Device Interface shall enable the system processor to access the various registers in the Viewer enclosure electronics and the photo data base module, under program control. Two program interrupt lines in this interface shall be used to interrupt the computer whenever certain operator requests are generated and when certain events take place, such as when the film frame mark is detected during the frame search mode.

The General Device Interface shall be part of the Interface Adapter Module. The interface adapter module shall also house D-to-A converters, a multiplexed (front end) A-to-D converter, incremental motor drive circuits,

V-scan encoder receiver circuits, and digital circuits to interface with the operator's controls and displays. The D-to-A converters and the A-to-D converter shall be standard DEC modules.

Table 4.2-1 lists the signals between the Interface Adapter Module and all other devices in the viewer enclosure. The discretes in this interface shall be grouped into 16-bit words. However, not all 16 bits need always be used. A typical program-controlled operation will require two words: the first word is sent by the program to indicate which parameter is to be accessed; and the second word is the parameter itself (input word or output word).

4.2.2.5 Digital Image Transceiver Module - The digital image transceiver module shall receive, demodulate, buffer and format digital imagery for immediate display by a Compass Preview console, and for recording with the digital image recorder module. The transceiver module shall also receive imagery from a Compass Preview Console, and format, buffer, modulate, and transmit that imagery to a remote location over a digital data link.

4.2.2.6 Digital Image Recorder Module - The digital image recorder module shall record incoming digital imagery to form a permanent record. This recording can be used later during detailed analysis, after the original digital imagery has been exploited in real time.

4.2.2.7 Remote Digital Image Viewer Module - The remote digital image viewer module shall conform to the specifications for the digital image viewer (Section 5 of this volume), with the following exceptions:

- Table top cabinet added
- The 17-inch diagonal (16-inch or larger radius of curvature face plate) CRT replaces the 10-inch or less diameter flat-faced CRT.

4.2.2.8 Photo Data Base Module - The photo data base module shall contain a modified Access System 60B retrieval unit that automatically extracts the proper transparent notch-coded envelope containing several historical installation film chips, when the film transport is slewed to an installation. The analyst will remove the desired chip and place it in a gate on the film transport for comparison display with the roll film.

The System 60B shall consist of the following:

- 2 trays
- 1 selector

TABLE 4.2-1 SIGNALS INTERNAL TO VIEWER ENCLOSURE

<u>Signal from Interface Unit to Other Devices</u>	<u>Type</u>	<u>No. of Lines</u>
Film Transport No. 1 Slew Motor Clutch	discrete	1
Film Transport No. 1 Slew Velocity Command	dc analog	1
Film Transport No. 1 Incr. Motor Clutch	discrete	1
Film Transport No. 1 X Incr. Motor Drive	pulse	4
Film Transport No. 1 Y Incr. Motor Drive	pulse	4
Film Transport No. 2 Slew Motor Clutch	discrete	1
Film Transport No. 2 Slew Velocity Command	dc analog	1
Film Transport No. 2 Incr. Motor Clutch	discrete	1
Film Transport No. 2 X Incr. Motor Drive	pulse	4
Film Transport No. 2 Y Incr. Motor Drive	pulse	4
Chip Film Gate X Incremental Motor Drive	pulse	4
Left Zoom Lens Incremental Motor Drive	pulse	4
Right Zoom Lens Incremental Motor Drive	pulse	4
Left Pechan Prism Rotation Velocity Command	dc analog	1
Right Pechan Prism Rotation Velocity Command	dc analog	1
Left Illumination Control Command	dc analog	1
Right Illumination Control Command	dc analog	1
Left Lens Flicker Shutter Command	dc analog	1
Right Lens Flicker Shutter Command	dc analog	1
Left Comparison Viewing Shield (Occluder)	discrete	1
Right Comparison Viewing Shield (Occluder)	discrete	1
Light Source Shutter Commands	discrete	4
Film Image No. 1 Mirror Incr. Motor Drive	pulse	4
Film Image No. 2 Mirror Incr. Motor Drive	pulse	4
Interpupillary Adjustment Drive Motor Commands	dc analog	2
Final Projection Mirror Drive Motor Commands	discrete	2
Diffuser Position Commands	discrete	2
Lamp Drive (mode, status, warning, etc.)	discrete	32
<u>Signals from Other Devices to Interface Unit</u>		
Film No. 1 Frame Detector Output	digital	12
Film No. 2 Frame Detector Output	digital	12
Film Transport No. 1 Shaft Speed (tachometer)	dc analog	1

TABLE 4.2-1 (Continued)

<u>Signals from Other Devices to Interface Unit(Continued)</u>	<u>Type</u>	<u>No. of Lines</u>
Film Transport No. 1 Shaft Position Encoder	pulse	1
Film Transport No. 1 Y Position Encoder	V-scan	25*
Film Transport No. 1 Take-Up Spool Radius	dc analog	1
Film Transport No. 1 Supply Spool Radius	dc analog	1
Film Transport No. 1 End of Film Signals	discrete	2
Film Transport No. 2 Shaft Speed (tachometer)	dc analog	1
Film Transport No. 2 Shaft Position Encoder	pulse	1
Film Transport No. 2 Y Position Encoder	V-scan	25*
Film Transport No. 2 Take-Up Spool Radius	dc analog	1
Film Transport No. 2 Supply Spool Radius	dc analog	1
Film Transport No. 2 End of Film Signals	discrete	2
Chip Film Gate X Position Encoder	V-scan	25*
Left Zoom Lens Position Encoder	V-scan	25*
Right Zoom Lens Position Encoder	V-scan	25*
Left Pechan Prism Angular Position Encoder	V-scan	25*
Right Pechan Prism Angular Position Encoder	V-scan	25*
Left Image Light Level Sensor	dc analog	2
Right Image Light Level Sensor	dc analog	2
Film Image No. 1 Mirror Position Encoder	V-scan	25*
Film Image No. 2 Mirror Position Encoder	V-scan	25*
Interpupilliary Adjustment Drive Position	discrete	2
Final Projection Mirror Position	discrete	2
Diffuser Position	discrete	2
Data Pen Position	digital	12
Control Panel Switch Inputs (mode, motor control, etc)	discrete	20 max.
Keyboard Signals	digital	14
Track Ball Signals — X-Y Control (2)	pulse	4
Rotation Control (2)	V-scan	50*

*V-scan encoders can be excited one at a time so that their output lines can be tied together, making it necessary to bring in only 25 signal lines and 11 excitation lines into the Interface Unit.

- 1 system processor interface. (This interface shall permit chip retrieval via computer selection or manual selection using the viewer console keyboards or manual selection with the data pen and the alphanumerics and graphics direct view display.)
- 200 5 x 8-inch carry cards (transparent notch-coded envelopes with a steel insert)
- 1 coder (for notch-coding carry cards).

4.3 Reliability

4.3.1 Operational Stability - The equipment shall operate with satisfactory performance, continuously or intermittently, for a period of at least * hours without the necessity for readjustment of any controls which are inaccessible to the operator during normal use.

4.3.2 Operating Life - The equipment should have a total operating life of * hours with reasonable servicing and replacement of parts.

4.3.3 Reliability in Terms of Mean Time Between Failures (MTBF) - The equipment should have * hours of mean operating time between failures.

4.4 Maintainability

4.4.1 General - The equipment shall be designed with maintenance features to achieve maximum facility and organizational level maintenance. The scope of the following paragraphs entails specific maintainability requirements that shall apply. The repairable characteristics of Compass Preview shall be such that it will be possible in approximately 90 percent of all cases of malfunction/failure to perform all corrective maintenance at the organizational level.

4.4.2 Maintenance Requirements - If failure occurs, emphasis on restoration of Compass Preview shall be by interchange of replaceable assemblies. The maintainability characteristics shall be as specified in the following paragraphs.

4.4.2.1 Mean-Time-To-Repair (MTTR) - The mean-time-to repair (MTTR) goal for Compass Preview to return it to operational readiness shall be 30 minutes. The goal for maximum time to repair shall be 1.5 hours in 95 percent of the maintenance tasks.

4.4.2.2 Preventive Maintenance - Scheduled preventive maintenance performed at the facility level (consisting of minor inspection, servicing, minor repair and/or replacement, and alignment/adjustment, that

*To be determined.

are within the capabilities and facilities at that level), shall not exceed 1 hour of maintenance per 24 operating hours. The design goal of Compass Preview shall be such that the need for any major maintenance tasks to be performed beyond facility and organization maintenance levels shall be accomplished at no less than 180-day intervals.

4.4.2.3 Equipment Placement - The maintainability design goals for Compass Preview shall reflect simplicity, accessibility, and serviceability. Component equipments shall be positioned and/or arranged so as to provide adequate servicing area and personnel space consistent with proper operation and the maintenance tasks performed on the equipment.

4.4.2.4 Accessibility - The design goal of the equipment enclosures shall be to provide easy and ready access to all assemblies and subassemblies and their interior parts or components for adjustments, checkouts, repair, and removal or replacement of parts without damage to adjacent units and without extensive disassembly. Electronic equipment shall be of unitized construction for individual drawer-type mounting, so that maintenance can be performed from the front and sides with the drawer extended. Each drawer shall be completely removable from its enclosure without extensive disassembly.

When the design of the equipment is such that sliding drawers are impractical and front or top access is technically not feasible, side and/or rear access doors and panels shall be incorporated into the design, and provisions shall be made to mount the equipment enclosure on rails, tracks or rollers. Accessibility to the side of rear access doors and panels shall be by sliding the equipment clear of bulkheads and adjacent equipment that might interfere with any maintenance task that must be performed.

4.4.2.5 Fastening Devices - All units shall be so designed that all panels, access doors, and drawers are secured by means of fastening devices that permit quick and easy fastening or unfastening without the need or use of any special tools. Fastening devices shall be of the captive type, and shall provide self-alignment with associated retaining nuts or blocks, and shall not stick or cause damage to threads.

4.4.2.6 Self-Test/Built-In-Test Equipment (BITE) - Self-test or BITE diagnostic features shall be considered for incorporation. Selection of the means and extent of the equipment to be tested shall be separately identified during equipment design.

4.2.2.7 Operational Checkout - Equipment shall have provisions for connecting such test equipment as may be required for necessary checkout tests. A minimum need for special test equipment or special connectors shall be a design goal.

4.2.2.8 Test Points - Test points that allow safe and convenient access to electronic circuits shall be provided. This access to circuits shall enable the following basic maintenance actions to be performed:

- (a) Recognition that a fault or performance degradation exists.
- (b) Isolation of the fault to the point at which repair can be effectively accomplished.
- (c) Verification that the fault or degradation has been corrected.

4.2.2.9 Time Meters - Time meters shall be considered for critical equipment components to indicate operational elapsed time. Identification of those equipments to be metered shall be identified during equipment design.

4.2.2.10 Special Tools - The equipment design shall be such that the need for special tools for calibration, adjusting, and/or servicing shall be minimized. Special tools shall not be required for the installation and/or replacement of electronic parts.

4.2.2.11 Power Protection - Each major equipment shall contain devices for protecting equipment against such conditions as variance of electrical power outside of specifications, over-heating, and other potentially damaging conditions.

4.4.2.12 Maintenance and Repair Cycles

4.4.2.12.1 Maintenance - Maintenance levels are organizational, field, and depot as defined in AFM 66-1.

4.4.2.12.2 Repair Cycles

- (a) Preventive (Scheduled) Maintenance - Maintenance which requires "power off" or causes operational degradation of the equipment shall be limited by the maximum permissible down-time of 1.5 hours per 24 operating hours.
- (b) Corrective Maintenance - The following shall be design goals:
 - (1) Facility - Corrective maintenance performed facility level shall require no more than 45 minutes in 24 hours of operation.
 - (2) Organization - Corrective maintenance performed at the organization level shall not normally be required more often than one hour per 500 hours of operation.

- (c) Overhaul - Depot overhaul/repair shall not be required more often than once in 5000 hours of operation (based on 8 hours of equipment operation per day), except for those emergency repairs which are beyond the capabilities of the lower levels.

4.5 Availability - The basic intended use of Compass Preview is in support of a continuously operating system, on an "as required" basis. Therefore, availability is a necessary system operating parameter. Reliability and maintainability shall be derived from the availability requirement. Availability shall be defined as the probability that Compass Preview is operating satisfactorily at any point in time when used under stated conditions.

4.5.1 Inherent Availability - Inherent availability is defined as:

$$\frac{MTBF}{MTBF + MTTR}, \text{ where: } MTFB = \text{mean time between failures}$$

MTTR = mean time to repair

The inherent availability goal for Compass Preview is to be determined.

4.5.2 Operational Availability - Operational availability is defined as:

$$\frac{MTBM}{MTBF + MTTR}, \text{ where: } MTBM = \text{mean time between maintenance}$$

The operational availability goal for Compass Preview is to be determined.

4.6 Quality Assurance Program

4.6.1 Responsibility for Tests - Unless otherwise specified in the contract or purchase order, the supplier shall be responsible for the performance of all test and inspection requirements as specified herein. Except as otherwise specified, the supplier may utilize his own facilities or any commercial laboratory acceptable to the Government.

The Government reserves the right to perform any of the inspections set forth in the specification, where such inspections are deemed necessary to ensure that supplies and services conform to prescribed requirements.

4.6.2 Quality Conformance Inspection

4.6.2.1 Classification of Tests - Testing and test support performed shall fall within the following classification:

- (a) Development Tests
- (b) Qualification Tests
- (c) Acceptance Tests

4.6.2.1.1 Development Tests - These tests, which are an integral part of the development process, are conducted by the contractor to acquire data to support the design and development process.

4.6.2.1.2 Qualification Tests - Qualification tests are inspections, analyses, demonstrations and tests that are accomplished by the contractor to demonstrate compliance with the specification. Testing shall be conducted in accordance with approved test plans/procedures. In the event that the equipment fails any part of the qualification tests, the failure shall be analyzed. The part that failed shall be replaced by the supplier at his expense, with either an equivalent part, a superior part, or design upgrading as is necessary to pass the test. The equipment shall then be retested. This process of change and retest shall continue until the specific test has been successfully completed. Each retest shall consist of completely repeating the failed test, starting from the beginning. Retest shall be conducted in the same configuration, under the same conditions and at the same levels of scope and intensity as specified in the original test.

4.6.2.1.2.1 Inspections

4.6.2.1.2.1.1 Equipment - The supplier shall provide and maintain the necessary inspection measuring and test equipment to assure that articles conform to the specification. The calibration of measuring and test equipment shall conform with MIL-C-45662.

4.6.2.1.2.1.2 Source Inspection - The procuring agency reserves the right to inspect the source of supplies or services manufactured/not manufactured at the supplier's facility. Source inspection as used herein is defined as an interim acceptance test only. Final acceptance by the procuring agency will be accomplished after receipt of the article or system.

4.6.2.1.2.1.3 Equipment Inspection - Inspections shall be conducted at the time and place of qualification testing. Inspection requirements shall be developed and subsequently published in the module specifications that support this system specification.

4.6.2.1.2.2 Analyses - Requirements to be verified by review of analytical data shall be developed and subsequently published in the module specifications that support this system specification.

4.6.2.1.2.3 Demonstration - Requirements to be verified by demonstration shall be developed and subsequently published in the module specifications that support this system specification.

4.6.2.1.2.4 Tests - The supplier, during Compass Preview analysis and design, shall identify the requirements in Section 4 that shall require verification during the formal test program.

4.6.2.1.2.4.1 Functional Characteristics - Functional characteristics identified during the analysis and design of Compass Preview shall require verification by formal tests. Test equipment shall be utilized to determine voltage and/or logic levels. Simulation devices that the equipment must interface with will be permissible to verify true performance capabilities.

4.6.2.1.2.4.2 Environmental - Environmental tests will be conducted in either the supplier's facility or a commercial laboratory acceptable to the procuring agency. Testing of requirements specified in 4.1.8 shall be held to the minimum essential tests to assure an operable system and shall be subject to approval of the procuring agency prior to initiating tests.

4.6.2.1.2.4.3 Electromagnetic Interference - Requirements of paragraph 4.1.7.2 shall be verified in an approved screen room in accordance with the methods and procedures of MIL-STD-461.

4.6.2.1.2.4.4 Reliability Testing - The equipment shall demonstrate minimum acceptable MTBF when tested by the procuring agency in accordance with the approved Reliability Test Plan.

4.6.2.1.2.4.5 Maintainability Testing - Tests performed by the supplier solely for the purpose of demonstrating conformance to the maintainability requirements will not be required. A maintainability demonstration, however, may be performed during system integration by the integration contractor.

4.6.2.1.3 Acceptance Test - The supplier shall perform all inspections, demonstrations, and tests outlined in the Acceptance Test Plan as a minimum. Approved test procedures shall be used to ensure that the equipment meets the functional and design requirements specified herein. The procuring agency reserves the right to witness any and all tests, in order to determine if the equipment meets specification.

Blank Page

Section 3
SPECIFICATION FOR A
ZOOM PROJECTION MODULE
FOR COMPASS PREVIEW

1.0 SCOPE

1.1 Scope - This specification states requirements for a Zoom Projection Module that will be used in Compass Preview to vary image scale and orientation of photographic transparencies. A single projection module shall be used to project a two-dimensional (mono) image. Two projection modules shall be used for projecting three-dimensional (stereo) images. At the operator's discretion, the projected images shall either be displayed on the viewing module, or imaged on the targets of the digital image cameras, via the digital image camera lenses, or imaged on the hard copy module.

1.2 Classification - The equipment covered by this specification shall consist of the following assemblies:

- Flip Mirror
- Zoom Lens (refer to Section 8 for specification)
- Pechan Assembly
- Pellicle Assembly.

1.3 Associated Equipment - The Zoom Projection Module shall interface with the following associated equipment:

- Illumination Module
- Film Transport Module
- Digital Image Camera Lens
- Viewing Module
- Hard Copy Module
- System Processor Module.

2.0 APPLICABLE DOCUMENTS

2.1 General - The following documents, of the issue in effect on , form a part of this specification to the extent specified herein.

SPECIFICATIONS

Military

MIL-C-45662	Calibration System Requirements
MIL-E-4158	Electronic Equipment, Ground
MIL-G-16592	Glass, Plate (For Optical Instruments)
MIL-M-13830	Optical Components for Fire Control Instruments, General Specification Governing the Manufacture, Assembly, and Inspection of
MIL-P-116F	Preservation, Methods of

Northrop

500-1	Northrop Quality Control Specification
-------	--

Standards

Military

MIL-STD-130	Identification Marking of U. S. Military Property
MIL-STD-150	Military Standard, Photographic Lenses
MIL-STD-195	Marking for Connection of Electrical Assemblies
MIL-STD-454	Standard General Requirement for Electronic Equipment
MIL-STD-461	Electromagnetic Interference Characteristics, Requirements for Equipment
MIL-STD-721	Definitions of Effectiveness Terms for Reliability, Maintainability, Human Factors, and Safety
MIL-STD-785	Requirements for Reliability Program
MIL-STD-810	Environmental Test Methods
MIL-STD-882	System Safety Program
MIL-STD-1241	Optical Terms and Definitions

Federal

FED-STD-102 Preservation, Packaging, and Packing

Other

AFM-66-1 Maintenance Management

MIL-HDBK-472 Maintainability Prediction

2.2 Availability of Documents - When requesting Specifications, Standards, and other publications refer to both title and number. Copies of Northrop documents required can be obtained from Northrop Corporation, Electronics Division, 1 Research Park, Palos Verdes Peninsula, California 90274. Copies of other applicable documents can be obtained from Document Engineering Company, Van Nuys, California 91405.

2.3 Precedence of Documents - When the requirements of the contract, this specification or applicable subsidiary specifications are in conflict, the following precedence shall apply:

- (1) Contract and Statement of Work - The contract and statement of work shall have precedence over this specification.
- (2) This Specification - This specification shall have precedence over the applicable documents listed herein. Any deviation from this specification, or from applicable documents, shall be specifically submitted in writing for approval by Northrop.
- (3) Applicable Documents - Applicable documents shall have precedence over subsidiary documents (those documents called out within the applicable documents).

3.0 REQUIREMENTS

3.1 Design and Development - This specification makes provision for the complete design and development.

3.2 Selection of Parts, Materials, and Processes - The selection of parts, materials, and processes shall be in accordance with MIL-E-4158 and MIL-STD-454, except as specified herein.

3.2.1 Marking of Parts - Each part used in fabrication and assembly shall be marked in accordance with good commercial practice. Connectors for electrical assemblies shall be marked in accordance with MIL-STD-195.

3.3 Design and Construction

3.3.1 General - The equipment shall conform to the requirements of good commercial practice for design, construction, and workmanship, except as specified herein.

3.3.2 Modular Construction - The equipment shall use modular construction techniques to the maximum extent consistent with good design practices. All modular assemblies shall be easily replaceable to permit rapid interchange with spare modules. To the maximum extent practical, these modules shall be of the plug-in type, to allow ease of removal and replacement for service, maintenance, and repair. Where the design requires electromechanical assemblies, the electronic parts shall be so grouped and mounted as to be easily removed from the mechanical assemblies.

3.3.3 Total Weight - The total weight of the Projection Module, complete with drive motors, position sensors, mirror and pellicle shall not exceed 90 pounds.

3.3.4 Reliability

3.3.4.1 Operational Stability - The equipment shall operate with satisfactory performance, continuously or intermittently, for a period of at least 40 hours without the necessity for readjustment of any controls which are inaccessible to the operator during normal use.

3.3.4.2 Operating Life - The equipment should have a total operating life of 4,000 hours with reasonable servicing and replacement of parts.

3.3.4.3 Reliability in Terms of Mean Time Between Failures (MTBF) - The equipment should have 1,000 hours of mean operating time between failures.

3.3.5 Cabling, Connections, and Connectors - Where practical, cabling, connections, and connectors shall be in accordance with MIL-STD-195. The location of interface and test connectors shall be subject to approval by Northrop.

3.3.6 Interference Control - Electromagnetic interference should be controlled within the limits of MIL-STD-461.

3.3.6.1 Inter-Equipment Cables - All inter-equipment cables shall be designed to restrict radiation of the signal being conducted by the cable to the lowest achievable level, within the practical physical cable limitations.

3.3.7 Provisions for Maintainability

3.3.7.1 Organizational Maintainability Requirements - Fault isolation should be unambiguous through the system to the specific equipment unit.

3.3.7.2 Intermediate Maintainability Requirements - Intermediate maintenance should be on the system element basis. Fault isolation shall be to the specific assembly. Equipment design shall be such that corrective action at the intermediate maintenance level can be performed with a Mean Time to Repair (MTTR) of 1 hour.

3.3.7.3 Accessibility - Access to circuit boards for test and repair should not require realignment of optical, electromagnetic, electronic, or mechanical assemblies or subassemblies.

3.3.8 Nomenclature and Nameplates - Northrop will supply nameplate data.

3.3.9 Standard Conditions - The following conditions will be used to establish normal performance characteristics of the equipment:

Temperature	Room ambient +70° F
Altitude	Normal Ground, =50' to +2,500'
Vibration	None
Humidity	Room Ambient, up to 90% relative humidity
Input Voltage	117 VAC, ±7V, 60 Hz

3.3.10 Service Conditions - The equipment shall be designed to meet the following environmental requirements.

3.3.10.1 Temperature - The equipment shall be capable of withstanding the temperatures specified below:

- (1) Operational Range - The equipment shall be designed to operate, after equipment warm-up, at temperatures from +32°F to +150°F.
- (2) Non-Operating Range -
 - (a) High Temperature - The equipment shall be designed to withstand high temperature storage of +165°F.

(b) Low Temperature - The equipment shall be designed to withstand low temperature storage of -10°F .

3.3.10.2 Air Pressure Range - The equipment shall be designed to operate in a pressure range of 29.92 to 20.58 inches of mercury (sea level to 10,000'). The equipment shall withstand a storage pressure of 3.44 inches of mercury (60,000' during air transportation).

3.3.10.3 Fungus Resistance - The equipment shall be designed and constructed without the utilization of any fungus nutrient material.

3.3.10.4 Warm-up Time - The equipment shall be designed so that full operating capability is achieved in not more than two minutes 30 seconds.

3.3.10.5 Overload Protection - All parts and circuits of the equipment which are likely to carry an overload shall withstand an overload without permanent damage to the equipment, or shall have suitable protective devices. The use of fuses or other protective devices is subject to the approval of Northrop.

3.3.10.6 Undervoltage Protection - The equipment shall not be damaged by voltages below the minimum specified herein and shall automatically return to normal operation when normal voltages are restored.

3.3.11 Interfaces

3.3.11.1 Mechanical Interface - The Projection Module shall conform to the envelope size and be equipped with mounting pads in accordance with the requirements shown on the specification control drawing.

3.3.11.2 Illumination Module Interface - The position, excursion, and size of the entrance pupil shall be as defined by the requirements shown on the specification control drawing.

3.3.11.3 Film Transport Module Interface - The nominal distance from the vertex of the lens nearest the film plane to the film plane itself shall be 12.00 ± 0.5 inches. The Projection Module shall be capable of accommodating changes in the film plane by having an internal focus adjustment.

3.3.11.4 Viewing Module Interface - The Projection Module shall have a nominal projection path length of 77.0 ± 2 inches measured from the vertex of the lens nearest to the viewing surface to the viewing surface itself. The exit pupil shall be located at a nominal distance of 83.5 inches from the viewing surface. The exit pupil location shall not vary more than ± 2.0 inches during the full zoom travel. The size of the exit pupil shall be not less than 0.3 inches nor more than 0.5 inches at any position of the zoom travel.

3.3.11.5 Low Magnification Adapter Module Interface - If a low magnification adapter lens is provided, it will permit the zoom projection module to image a $9-1/2'' \times 9-1/2''$ field of view at low magnification (2X or less).

3.3.11.6 System Processor Module Interface - The illumination module shall respond to the following commands from the system processor module:

- Magnification Increase
- Magnification Decrease
- Image Rotation - Clockwise
- Image Rotation - Counterclockwise
- Flip Mirror - Up
- Flip Mirror - Down

The Projection Module shall provide feedback signals which indicate the following:

- Zoom Position (Magnification)
- Image Rotation (Relative to Film)
- Flip Mirror Position (Up-Down)

3.3.11.7 Digital Image Camera Lens Interface - The Projection Module shall be equipped with a pellicle beam splitter that permits 5 ft. candles of illumination from the projection lens to be diverted to the Digital Image Camera Lens, with 3% transmittance film.

3.3.11.8 Hard Copy Module Interface - The hard copy module interface shall be identical to the viewing module interface (3.3.11.4), except that an additional fold shall be placed in the optical path to direct the image to the hard copy module instead of to the viewing module.

3.3.12 Power Consumption - The Projection Module shall not consume more than 150 watts of power.

3.4 Performance

3.4.1 Resolution - The Projection Module shall exhibit the below stated polychromatic resolution when using a high-contrast (1000:1) Standard Air Force resolution test target containing test patterns including the group 9-6. The resolution shall be measured in the aerial image.

<u>Position</u>	<u>Line pairs/mm/power</u>
Axial	5
11" Off-Axis	4

3.4.2 Focus Shift - The Projection Module shall not require refocusing to meet the foregoing resolution requirements.

3.4.3 Magnification Range - The Projection Module shall be capable of providing a continuously variable magnification from 5X to 100X. A device shall be provided to indicate magnification with a resolution of 1%, and a repeatability within ± 1 resolution count.

3.4.4 Time for Zoom - The Projection Module shall be capable of covering the complete magnification range in not more than 6 seconds.

3.4.5 Field of View - The Projection Module shall cover a field of view not less than 4.5 inches at the 5-X position.

3.4.6 Projected Image Size - The projected image shall not be less than $22.5 \pm .5$ inches in diameter at the lowest magnification.

3.4.7 Light Transmission - The Projection Module shall be capable of transmitting at least 65% of the illumination.

3.4.8 Distortion - The Projection Module shall exhibit no more than 5% radial distortion at any magnification.

3.4.9 Interpupillary Adjustment - If an interpupillary adjustment is required, it shall be provided for by the projection module.

3.4.10 Image Rotation - The Projection Module shall contain a device for optically rotating the image. The device shall be actuated by an electric motor which responds to position commands. A device to provide a position feedback signal shall be incorporated. This device shall indicate the relative image rotation with a resolution of 0.1° , and a repeatability within ± 1 resolution count.

3.4.11 Focus - The Projection Module shall incorporate a device to optically compensate for variations in the film plane. This device shall permit meeting all the requirements of paragraph 3.4.1 when the film plane is displaced by ± 0.03 inches.

3.4.12 Controls - The controls for the Projection Module shall not be considered a part of the Projection Module itself. The Projection Module shall, however, be capable of responding to the commands cited in paragraph 3.3.11.6. Signal levels and wave forms shall be established during the detail design phase.

4.0 QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for Inspection - Unless otherwise specified in the contract, the supplier shall conduct a quality assurance program which is compatible with Northrop Quality Control Specification 500-1. This document shall be effective for the duration of the contract. The supplier is responsible for the performance of all inspection requirements as specified herein. The Supplier may use his own facilities or any commercial laboratory acceptable to Northrop. Northrop and the Government reserve the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure that the equipment conforms to the prescribed requirements.

In addition to the tests required to be performed by the Supplier, as described herein, the equipment will be subjected to further laboratory and operational tests by Northrop and the Government. These tests may include functional, environmental, and EMI tests at the subsystem and system level. The Supplier shall provide technical and logistic support for these tests as defined in the statement of work.

4.1.1 Classification of Tests - The equipment covered by this specification shall be subject to the following tests:

- (1) Design Approval Tests
 - (a) Equipment Bench Tests
- (2) Acceptance Tests
 - (a) Bench Tests
 - (b) Environmental Burn-In

4.2 Design Approval Tests - Design approval tests shall be conducted by the Supplier on one equipment unit as defined in the statement of work. Tests shall be accomplished under the approved test procedures established in 4.4. Northrop shall be advised at least 10 days prior to conducting the tests so that a Northrop and/or a Government representative can witness or supervise the tests if desired.

4.2.1 Design Approval Test Data - The Supplier shall submit all data collected in conducting these tests to Northrop for review and approval. The Supplier shall monitor the total hours of equipment operation during the tests, and furnish such data to Northrop at the time of equipment delivery.

4.2.2 Scope of Tests

4.2.2.1 Equipment Bench Tests - Bench tests shall be conducted by the Supplier to demonstrate all the requirements of Section 3. The Supplier shall furnish specific test methods in the test procedures required by 4.4.

4.3 Acceptance Tests - Each equipment submitted for acceptance shall be subjected to bench tests and environmental burn-in by the Supplier. Tests shall be accomplished under the approved test procedures established in 4.4. Northrop shall be advised at least 10 days prior to conduct of the tests so that a Northrop and/or a Government representative can witness the tests when desired.

4.3.1 Acceptance Test Data - The Supplier shall submit all data collected in conducting these tests, including equipment operating times, to Northrop for review and approval.

4.3.2 Scope of Tests - Design and development acceptance tests shall be adequate to determine compliance with the requirements of material, workmanship, and functional performance and to serve as an indication of reliability.

4.3.2.1 Acceptance Bench Tests - Bench tests shall be conducted by the Supplier to demonstrate compliance with form, fit, and function requirements as defined in Section 3.

4.4 Test Procedures - The procedures used for conducting the Equipment Design Approval and Acceptance Tests shall be prepared by the Supplier and submitted to Northrop for review and approval.

4.5 Reconditioning of Tested Equipment - Equipment that has been subjected to Acceptance Test shall be reconditioned by the Supplier by replacing all worn or damaged items. After reworking, the Supplier shall resubmit the equipment for Acceptance Bench Tests (4.3.2.1).

4.6 Pre-Testing - No item, part, or complete equipment shall be Design Approved or Acceptance Tested by the Supplier until it has been previously operated, checked, and inspected by the Supplier and found to comply, to the best of his knowledge and belief, with all of the applicable requirements.

4.7 Rejection and Retest - Equipment which has been rejected shall have corrective action taken and shall be resubmitted for acceptance. Before resubmitting, a full account of the cause for rejection and the corrective action taken shall be furnished to Northrop.

5.0 PREPARATION FOR DELIVERY

5.1 Packaging and Shipping - The Supplier shall package and ship the equipment in accordance with best commercial practice. Marking of all packages and shipping containers shall be in accordance with MIL-STD-129.

6.0 NOTES

6.1 Performance Objectives - Simplicity of operation, ease of maintenance, good reliability, and improved performance of the specific functions beyond the requirements of this specification are design objectives. When it appears that a substantial improvement in any of these areas will result from the use of materials, parts, or process other than those specified in this specification, their use shall be investigated. Where such investigation shows that an advantage can be realized, a request for approval shall be submitted to Northrop for consideration.

Section 4

SPECIFICATION FOR A

DIGITAL IMAGE CAMERA MODULE

FOR COMPASS PREVIEW

1.0 SCOPE

1.1 Scope - This specification states requirements for a digital image camera module that will be used in Compass Preview to image transilluminated photographic transparencies and form a video signal that represents the temporally and spatially varying scene illumination. This video signal will in turn be displayed, recorded, or transmitted.

The video signal output of the digital image camera module will be analog. A/D conversion of this signal, when it is performed for data link transmission purposes, will take place external to this module. Similarly, the video signal input to the digital image viewer module will be analog. The camera analog output will be hardwired to a viewer analog input in some modes of operation (i.e., no A/D or D/A conversion will take place).

1.2 Classification - The equipment covered by this specification shall consist of the following assemblies:

- Camera Head
- Control Unit
- Remote Control Panel
- Sync Generator
- Power Supply

These assemblies, with the exception of the remote control panel, may be packaged together or separately.

1.3 Associated Equipment - The digital image camera module shall interface with the following associated equipment:

- Digital Image Camera Lens
- Digital Image Viewer Module
- Digital Image Transceiver Module
- Digital Image Recorder Module
- Digital Image Enclosure Module
- Video Mixer-Switcher Module

2.0 APPLICABLE DOCUMENTS

2.1
effect on
specified herein.

General - The following documents, of the issue in
, form a part of this specification to the extent

SPECIFICATIONS

Military

MIL-C-45662	Calibration System Requirements
MIL-E-4158	Electronic Equipment, Ground
MIL-P-116	Preservation, Methods of

STANDARDS

Military

MIL-STD-130	Identification Marking of U. S. Military Property
MIL-STD-150	Military Standard, Photographic Lenses
MIL-STD-195	Marking for Connection of Electrical Assemblies
MIL-STD-454	Standard General Requirement for Electronic Equipment
MIL-STD-461	Electromagnetic Interference Characteristics, Requirements for Equipment
MIL-STD-721	Definitions of Effectiveness Terms for Reliability, Maintainability, Human Factors, and Safety
MIL-STD-749	Preparation and Submission of Data for Approval of Non-Standard Electronic Parts
MIL-STD-785	Requirements for Reliability Program
MIL-STD-810	Environmental Test Methods
MIL-STD-882	System Safety Program

Federal

FED-STD-102	Preservation, Packaging, and Packing
-------------	--------------------------------------

Other

AFM-66-1	Maintenance Management
MIL-HDBK-472	Maintainability Prediction

2.2 Availability of Documents - When requesting Specifications, Standards, and other publications refer to both title and number. Copies of Northrop documents required can be obtained from Northrop Corporation, Electronics Division, 1 Research Park, Palos Verdes Peninsula, California 90274. Copies of other applicable documents can be obtained from Document Engineering Company, Van Nuys, California 91405.

2.3 Precedence of Documents - When the requirements of the contract, this specification or applicable subsidiary specifications are in conflict, the following precedence shall apply:

- (1) Contract and Statement of Work - The contract and statement of work shall have precedence over this specification.
- (2) This Specification - This specification shall have precedence over the applicable documents listed herein. Any deviation from this specification, or from applicable documents, shall be specifically submitted in writing for approval by Northrop.
- (3) Applicable Documents - Applicable documents shall have precedence over subsidiary documents (those documents called out within the applicable documents).

3.0 REQUIREMENTS

3.1 Design and Development - This specification makes provision for limited design and development.

3.2 Selection of Parts, Materials, and Processes - The selection of parts, materials and processes shall be in accordance with MIL-E-4158 and MIL-STD-454, except as specified herein.

3.2.1 Marking of Parts - Each part used in fabrication and assembly shall be marked in accordance with good commercial practice. Connectors for electrical assemblies shall be marked in accordance with MIL-STD-195.

3.3 Design and Construction

3.3.1 General - The equipment shall conform to the requirements of good commercial practice for design, construction, and workmanship, except as specified herein.

3.3.2 Modular Construction - The equipment shall use modular construction techniques to the maximum extent consistent with good design practices. All modular assemblies shall be easily replaceable to permit rapid interchange with spare modules. To the maximum extent practical, these modules shall be of the plug-in type, to allow ease of removal and replacement for service, maintenance, and repair. Where the design requires electromechanical assemblies, the electronic parts shall be so grouped and mounted as to be easily removed from the mechanical assemblies.

3.3.3 Total Weight - The total weight of the digital image camera head shall not exceed 50 pounds.

3.3.4 Reliability

3.3.4.1 Operational Stability - The equipment shall operate with satisfactory performance, continuously or intermittently, for a period of at least 40 hours without the necessity for readjustment of any controls which are inaccessible to the operator during normal use.

3.3.4.2 Operating Life - The equipment should have a total operating life of 4,000 hours with reasonable servicing and replacement of parts.

3.3.4.3 Reliability in Terms of Mean Time Between Failures (MTBF) - The equipment should have 1,000 hours of mean operating time between failures.

3.3.5 Cabling, Connections, and Connectors - Where practical, cabling, connections, and connectors shall be selected in accordance with MIL-STD-195. The location of interface and test connectors shall be subject to approval by Northrop.

3.3.6 Interference Control - Electromagnetic interference should be controlled within the limits of MIL-STD-461.

3.3.6.1 Inter-Equipment Cables - All inter-equipment cables shall be designed to restrict radiation of the signal being conducted by the cable to the lowest achievable level, within the practical physical cable limitations.

3.3.7 Provisions for Maintainability

3.3.7.1 Organizational Maintainability Requirements - Fault isolation shall be unambiguous through the system to the specific equipment unit.

3.3.7.2 Intermediate Maintainability Requirements - Intermediate maintenance shall be on the system element basis. Fault isolation shall be to the specific assembly. Equipment design should be such that corrective action at the intermediate maintenance level can be performed with a Mean Time to Repair (MTTR) of 1 hour.

3.3.7.3 Accessibility - Access to circuit boards for test and repair should require realignment of optical, electromagnetic, electronic, or mechanical assemblies or subassemblies.

3.3.8 Nomenclature and Nameplates - Northrop will supply nameplate data.

3.3.9 Standard Conditions - The following conditions will be used to establish normal performance characteristics of the equipment:

Temperature	+60° to +90°F
Altitude	Normal Ground, -50' to +2,500'
Vibration	None
Humidity	5% to 90% relative humidity
Input Voltage	117 VAC ±10%, 60 Hz

3.3.10 Service Conditions - The equipment should be designed to meet the following environmental requirements.

3.3.10.1 Temperature - The equipment should be capable of withstanding the temperatures specified below:

(1) Operational Range - The equipment should be designed to operate, after equipment warm-up, at temperatures from +32°F to +100°F.

(2) Non-Operating Range -

(a) High Temperature - The equipment should be designed to withstand high temperature storage of +140°F.

- (b) Low Temperature - The equipment should be designed to withstand low temperature storage of -80°F.

3.3.10.2 Air Pressure Range - The equipment shall be designed to operate in a pressure range of 29.92 to 20.58 inches of mercury (sea level to 10,000'). The equipment shall withstand a storage pressure of 3.44 inches of mercury (50,000' during air transportation).

3.3.10.3 Fungus Resistance - The equipment shall be designed and constructed without the utilization of any fungus nutrient material.

3.3.10.4 Warm-Up Time - The equipment shall be designed so that full operating capability is achieved in not more than two minutes 30 seconds.

3.3.10.5 Overload Protection - All parts and circuits of the equipment which are likely to carry an overload shall withstand an overload without permanent damage to the equipment, or shall have suitable protective devices. The use of fuses or other protective devices is subject to the approval of Northrop.

3.3.10.6 Undervoltage Protection - The equipment shall not be damaged by voltages below the minimum specified herein and shall automatically return to normal operation when normal voltages are restored.

3.3.10.7 Sweep Protection - A sweep protection circuit shall be provided to prevent damage to the camera sensor(s) in the event a sweep failure occurs.

3.3.11 Physical Dimensions - Physical dimensions of the equipment shall not exceed the following:

- (1) Camera Head - 22" long x 11" wide x 7" high (including Control Unit, if so packaged)
- (2) Control Unit - 19" wide x 22" deep x 8-3/4" high (if packaged separate from the Camera Head)

3.3.12 Interfaces

3.3.12.1 Electrical Interface - Coaxial cables used to connect the digital image camera module with interfacing modules shall use female BNC terminations at each end. Cables used between the digital camera head and a remote control panel or a remote control unit shall be 10 feet long.

Signals generated by the digital camera to drive other equipment shall consist of the following:

<u>Signal</u>	<u>Description</u>	<u>Load Impedance</u>
Horizontal Drive	TBD	75 Ohms
Vertical Drive	TBD	"
Sync	TBD	"
Blanking	TBD	"
Picture Video	TBD	"

These signals shall be provided in parallel with at least 40 db isolation between them so that, e.g., a digital image viewer and a digital image recorder may be driven in parallel. Suitable terminations shall be provided so that only one output can be used at a time, if desired. See 3.4 for a further definition of these signals.

The electrical interface of the digital image camera module with all other modules is analog. A/D conversion, when it is performed for data link transmission purposes, will take place external to this module.

3.3.12.2 Mechanical Interface - A flat machined plate shall be provided for attaching the digital camera head to the zoom projection module. This plate shall have 4-1/4-20 tapped holes spaced 2" on centers. The plate shall be parallel to the digital camera head axis $\pm 0.5^\circ$ or better.

The lens mount on the front of the camera head shall accept Nikkor-type 35 mm lenses and extension tubes, and hold the lens optical axis and the digital camera head electrical axis coincident within $\pm 0.5^\circ$.

If packaged separately, the control unit, sync generator, and power supply shall be supplied in a cabinet(s) suitable for 19" relay rack installation.

3.3.12.3 Illumination Interface - The light level impinging on the digital image camera sensor(s) will be controlled in the range 2-10 foot candles. Illumination will be provided by a xenon arc.

3.3.13 Power Consumption - The digital image camera module shall consume no more than 300 watts of power.

3.3.14 Finish - The digital image camera assemblies mounted within the enclosure shall be painted non-reflecting flat black.

3.4 Performance

3.4.1 Resolution

3.4.1.1 Horizontal Resolution - Limiting horizontal resolution shall exceed 2000 TV lines on-axis, and 1500 TV lines in the worst locations in the field of view. 50% response or better shall be achieved at 1000 TV lines, and 20% response or better shall be achieved at 1500 TV lines, on-axis.

3.4.1.2 Vertical Resolution and Scan Lines - Sufficient scan lines shall be employed to sensibly achieve vertical resolution equal to the horizontal resolution specified in 3.4.1.1 at 50% and 20% response.

3.4.2 Gray Scale - At least 12 0.15 density difference gray shades shall be resolved on both vertical and horizontal targets, anywhere in the image area. Resolution of 15 gray shades shall be a design goal. These gray shades should be obtained simultaneous with the resolution specified in 3.4.1.

3.4.3 Aspect Ratio - The aspect ratio shall be circular or 1:1 (square).

3.4.4 Interlace - Selectable interlace shall be supplied as follows:

- Non-interlace
- 4:1

The addition of 2:1, 3:1, and 5:1 interlace selections shall be a design goal.

3.4.5 Frame Rate - A frame rate of 15 frames/sec shall be provided. Selectable frame rates of 7.5, 10 and 15 frames/sec shall be a design goal.

3.4.6 Signal/Noise - Signal/noise shall be 40 dB or better for a bandwidth of 10 MHz. Full bandwidth S/N shall be 30 dB or better.

$$\text{signal/noise} = 20 \log_{10} \frac{\text{video volts (peak-to-peak)}}{\text{noise volts (root-mean-square)}}$$

An improvement in signal/noise with a decrease in frame rate (i.e., bandwidth) is a design goal.

3.4.7 Positional Error - Maximum positional error due to scanning nonlinearities and other geometric distortions shall not exceed $\pm 1\%$, as tested with an EIA grating and ball chart.

3.4.8 Uniformity - Uniformity shall be 70% or better anywhere in the image area, when operating with the resolution specified in 3.4.1 and scanning all-white, all-black, and 50% gray targets.

3.4.9 Recovery Time - The recovery time following operation with a 50% gray target shall not exceed 10 second.

3.4.10 Controls - A minimum number of controls is desired for normal operation. All frequently-used controls shall be mounted on a remote control panel. (See Figure 3-45, Vol. I). Adjustable controls should use multiturn high-resolution pots or similar devices that permit precision adjustments. The control panel design shall be approved by Northrop.

3.4.10.1 Focus

3.4.10.1.1 Electrical Focus - A capability to adjust electrical focus so as to obtain maximum resolution should be provided if the digital camera employs a focusable electron beam.

3.4.10.1.2 Optical Focus - A capability to adjust the distance between the sensor(s) and the external optics shall be provided. An adjustment of at least $\pm 0.2''$ is desired.

3.4.10.2 Enhancement Controls

3.4.10.2.1 Aperture Correction - Aperture correction should be provided as required to meet the requirements of 3.4.1.

3.4.10.2.2 Gamma Adjustment - Provision shall be made for adjusting the camera gamma in either direction from its nominal value.

3.4.10.2.3 Polarity - A capability shall be provided to change the polarity of the digital camera video. A polarity change shall not require re-adjustment of any controls on the digital image camera in order to obtain a satisfactory output.

3.4.10.2.4 Video Slice and Stretch - A capability should be provided to extract a portion (a slice) of the image gray scale, and stretch or expand it so that the output video has a full gray scale. The start and end points of the slice should be adjustable by the operator.

3.4.10.2.5 Edge Enhancement - A horizontal edge enhancement capability should be provided if it can be added at low cost. The degree of enhancement should be adjustable.

3.4.11 Scan Direction - The direction of the scan will be specified at a later date.

3.4.12 Jitter - Jitter shall be controlled so as to obtain the resolution specified in 3.4.1 over a 3 second period.

3.4.13 Stability - The stability of the equipment shall be such that no more than 0.25% drift occurs per 24 hours, after a 10 minute warm-up.

4.0 QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for Inspection - The Supplier is responsible for the performance of all inspection requirements as specified herein. The Supplier may use his own facilities or any commercial laboratory acceptable to Northrop. Northrop and the Government reserve the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure that the equipment conforms to the prescribed requirements.

In addition to the tests required to be performed by the Supplier, as described herein, the equipment may be subjected to further laboratory and operational tests by Northrop and the Government. These tests will include functional, environmental, and EMI tests at the subsystem and system level. The Supplier shall provide technical and logistic support for these tests as defined in the statement of work.

4.1.1 Classification of Tests - The equipment covered by this specification shall be subject to the following tests:

(1) Design Approval Tests

(a) Equipment Bench Tests

(2) Acceptance Tests

(a) Bench Tests

(b) Environmental Burn-In

4.2 Design Approval Tests - Design approval tests shall be conducted by the Supplier on one equipment unit as defined in the statement of work. Tests shall be accomplished under the approved test procedures established in 4.4. Northrop shall be advised at least 10 days prior to conducting the tests so that a Northrop and/or a Government representative can witness or supervise the tests if desired.

4.2.1 Design Approval Test Data - The Supplier shall submit all data collected in conducting these tests to Northrop for review and approval. The Supplier shall monitor the total hours of equipment operation during the tests, and furnish such data to Northrop at the time of equipment delivery.

4.2.2 Scope of Tests

4.2.2.1 Equipment Bench Tests - Bench tests shall be conducted by the Supplier to demonstrate the requirements of Section 3. The Supplier shall furnish specific test methods in the test procedures required by 4.4.

4.3 Acceptance Tests - Each equipment submitted for acceptance shall be subjected to bench tests and environmental burn-in by the Supplier. Tests shall be accomplished under the approved test procedures established in 4.4. Northrop shall be advised at least 10 days prior to conduct of the tests so that a Northrop and/or a Government representative can witness the tests when desired.

4.3.1 Acceptance Test Data - The Supplier shall submit all data collected in conducting these tests, including equipment operating times, to Northrop for review and approval.

4.3.2 Scope of Tests - Design and development acceptance tests shall be adequate to determine compliance with the requirements of material, workmanship, and functional performance and to serve as an indication of reliability.

4.3.2.1 Acceptance Bench Tests - Bench tests shall be conducted by the Supplier to demonstrate compliance with form, fit, and function requirements as defined in Section 3.

4.3.2.2 Environmental Burn-In - Each equipment to be submitted for acceptance shall be subjected to an environmental stressed burn-in for the purpose of establishing a reasonable confidence level with respect to the environmental integrity of the design and for the purpose of eliminating early life failure.

Equipment shall be cycled through all operating modes during the burn-in, allowing approximately equal operating time for each mode.

Should a failure occur, it should be repaired and the cycle started over. Should any failure (or failures) occur that indicate a design deficiency, or a repetitive component failure or defect, corrective action shall be taken to eliminate this deficiency from all units. A record shall be kept of all failures.

4.4 Test Procedures - The procedures used for conducting the Equipment Design Approval and Acceptance Tests shall be prepared by the Supplier and submitted to Northrop for review and approval.

4.5 Reconditioning of Tested Equipment - Equipment that has been subjected to Acceptance Tests shall be reconditioned by the Supplier by replacing all worn or damaged items. After reworking, the Supplier shall resubmit the equipment for Acceptance Bench Tests (4.3.2.1).

4.6 Pre-Testing - No item, part, or complete equipment shall be Design Approval or Acceptance Tested by the Supplier until it has been previously operated, checked, and inspected by the Supplier and found to comply, to the best of his knowledge and belief, with all of the applicable requirements.

4.7 Rejection and Retest - Equipment which has been rejected shall have corrective action taken and shall be resubmitted for acceptance. Before resubmitting, a full account of the cause for rejection and the corrective action taken shall be furnished to Northrop.

5.0 PREPARATION FOR DELIVERY

5.1 Packaging and Shipping - The Supplier shall package and ship the equipment in accordance with best commercial practice. Marking of all packages and shipping containers shall be in accordance with MIL-STD-129.

6.0 NOTES

6.1 Performance Objectives - Simplicity of operation, ease of maintenance, good reliability, and improved performance of the specific functions beyond the requirements of this specification are design objectives. When it appears that a substantial improvement in any of these areas will result from the use of materials, parts, or processes other than those specified in this specification, their use shall be investigated. Where such investigation shows that an advantage can be realized, a request for approval shall be submitted to Northrop for consideration.

Section 5

SPECIFICATION FOR A

DIGITAL IMAGE VIEWER MODULE

FOR COMPASS PREVIEW

1.0 SCOPE

1.1 Scope - This specification states requirements for a digital image viewer module that will be used in Compass Preview to display, via projection, video imagery that is either received from a scan converter connected to a data link, or is received via hard wire from a digital image camera or another digital image viewer. This display will be monocular at times. Two displays from two separate digital image viewers can also be combined to present a stereo display, using the viewing module.

The video signal input to the digital imager viewer module will be analog. D/A conversion of a digital input signal, as might be experienced for data link reception purposes, will take place external to this module. Similarly, the video signal output to another digital image viewer module will be analog. The digital image camera module analog output will be hardwired to a viewer analog input in some modes of operation (i.e., no A/D or D/A conversion will take place).

1.2 Classification - The equipment covered by this specification shall consist of the following assemblies:

- Digital Image Viewer Chassis
- Digital Image Viewer Display Tube
- Remote Control Panel
- Power Supply

1.3 Associated Equipment - The digital image viewer module shall interface with the following associated equipment:

- Digital Image Camera Module
- Digital Image Transceiver Module
- Video Mixer-Switcher Module
- Digital Image Viewer Projection Lens
- Digital Image Enclosure Module

2.0 APPLICABLE DOCUMENTS

2.1 General - The following documents of the issue in effect on , form a part of this specification to the extent specified herein.

SPECIFICATIONS

Military

MIL-C-45662	Calibration System Requirements
MIL-E-4158	Electronic Equipment, Ground
MIL-P-116	Preservation, Methods of

STANDARDS

Military

MIL-STD-130	Identification Marking of U.S. Military Property
MIL-STD-150	Military Standard, Photographic Lenses
MIL-STD-195	Marking for Connection of Electrical Assemblies
MIL-STD-454	Standard General Requirement for Electronic Equipment
MIL-STD-461	Electromagnetic Interference Characteristics, Requirements for Equipment
MIL-STD-721	Definitions of Effectiveness Terms for Reliability, Maintainability, Human Factors, and Safety
MIL-STD-749C	Preparation and Submission of Data for Approval of Non-Standard Electronic Parts
MIL-STD-785	Requirements for Reliability Program
MIL-STD-810	Environmental Test Methods
MIL-STD-882	System Safety Program

Federal

FED-STD-102	Preservation, Packaging, and Packing
-------------	--------------------------------------

Other

AFM-66-1	Maintenance Management
MIL-HDBK-472	Maintainability Prediction

2.2 Availability of Documents - When requesting Specifications, Standards, and other publications refer to both title and number. Copies of Northrop documents required can be obtained from Northrop Corporation, Electronics Division, 1 Research Park, Palos Verdes Peninsula, California 90274. Copies of other applicable documents can be obtained from Document Engineering Company, Van Nuys, California 91405

2.3 Precedence of Documents - When the requirements of the contract, this specification or applicable subsidiary specifications are in conflict, the following precedence shall apply:

- (1) Contract and Statement of Work - The contract and statement of work shall have precedence over this specification.
- (2) This Specification - This specification shall have precedence over the applicable documents listed herein. Any deviation from this specification, or from applicable documents, shall be specifically submitted in writing for approval by Northrop.
- (3) Applicable Documents - Applicable documents shall have precedence over subsidiary documents (those documents called out within the applicable documents).

3.0 REQUIREMENTS

3.1 Design and Development - This specification makes provision for limited design and development.

3.2 Selection of Parts, Materials, and Processes - The selection of parts, materials, and processes shall be in accordance with MIL-E-4158 and MIL-STD-454, except as specified herein.

3.2.1 Marking of Parts - Each part used in fabrication and assembly shall be marked in accordance with good commercial practice. Connectors for electrical assemblies shall be marked in accordance with MIL-STD-195.

3.3 Design and Construction

3.3.1 General - The equipment shall conform to the requirements of good commercial practice for design, construction, and workmanship, except as specified herein.

3.3.2 Modular Construction - The equipment shall use modular construction techniques to the maximum extent consistent with good design practices. All modular assemblies shall be easily replaceable to permit rapid interchange with spare modules. To the maximum extent practical, these modules shall be of the plug-in type, to allow ease of removal and replacement for service, maintenance, and repair. Where the design requires electromechanical assemblies, the electronic parts shall be so grouped and mounted as to be easily removed from the mechanical assemblies.

3.3.3 Physical Weight and Size

3.3.3.1 Total Weight - The total weight of the digital image viewer display tube and any associated mounting yoke and gimbaling shall not exceed 80 pounds.

3.3.3.2 Dimensions - Physical dimensions of the digital image display tube shall not exceed 11" in diameter, including mounting provisions and gimbaling, if required. Overall length shall not exceed 22".

3.3.4 Reliability

3.3.4.1 Operational Stability - The equipment shall operate with satisfactory performance, continuously or intermittently, for a period of at least 40 hours without the necessity for readjustment of any controls which are inaccessible to the operator during normal use.

3.3.4.2 Operating Life - The equipment should have a total operating life of 4,000 hours with reasonable servicing and replacement of parts.

3.3.4.3 Reliability in Terms of Mean Time Between Failures (MTBF) - The equipment should have 1,000 hours of mean operating time between failures.

3.3.5 Cabling, Connections, and Connectors - Where practical, cabling, connections, and connectors shall be in accordance with MIL-STD-195. The location of interface and test connectors shall be subject to approval by Northrop.

3.3.6 Interference Control - Electromagnetic interference should be controlled within the limits of MIL-STD-461.

3.3.6.1 Inter-Equipment Cables - All inter-equipment cables shall be designed to restrict radiation of the signal being conducted by the cable to the lowest achievable level, within the practical physical cable limitations.

3.3.7 Provisions for Maintainability

3.3.7.1 Organizational Maintainability Requirements - Fault isolation should be unambiguous through the system to the specific equipment unit.

3.3.7.2 Intermediate Maintainability Requirements - Intermediate maintenance shall be on the system element basis. Fault isolation shall be to the specific assembly. Equipment design should be such that corrective action at the intermediate maintenance level can be performed with a Mean Time to Repair (MTR) of 1 hour.

3.3.7.3 Accessibility - Access to circuit boards for test and repair should not require realignment of optical, electromagnetic, electronic, or mechanical assemblies or subassemblies.

3.3.8 Nomenclature and Nameplates - Northrop will supply nameplate data.

3.3.9 Standard Conditions - The following conditions will be used to establish normal performance characteristics of the equipment:

Temperature	75°F ± 20°F
Altitude	Normal ground, -50' to +2,500'
Vibration	None
Humidity	5% to 90% relative humidity
Input Voltage	117 VAC, ±10%, 60 Hz

3.3.10 Service Conditions - The equipment should be designed to meet the following environmental requirements.

3.3.10.1 Temperature - The equipment should be capable of withstanding the temperatures specified below:

- (1) Operational Range - The equipment should be designed to operate, after equipment warm-up, at temperatures from +32°F to +100°F.
- (2) Non-Operating Range
 - (a) High Temperature - The equipment should be designed to withstand high temperature storage of +160°F.
 - (b) Low Temperature - The equipment should be designed to withstand low temperature storage of -80°F.

3.3.10.2 Air Pressure Range - The equipment shall be designed to operate in a pressure range of 29.92 to 20.58 inches of mercury (sea level to 10,000'). The equipment shall withstand a storage pressure of 3.44 inches of mercury (50,000' during air transportation).

3.3.10.3 Fungus Resistance - The equipment shall be designed and constructed without the utilization of any fungus nutrient material.

3.3.10.4 Warm-Up Time - The equipment shall be designed so that full operating capability is achieved in not more than two minutes 30 seconds.

3.3.10.5 Overload Protection - All parts and circuits of the equipment which are likely to carry an overload shall withstand an overload without permanent damage to the equipment, or shall have suitable protective devices. The use of fuses or other protective devices is subject to the approval of Northrop.

3.3.10.6 Undervoltage Protection - The equipment shall not be damaged by voltages below the minimum specified herein and shall automatically return to normal operation when normal voltages are restored.

3.3.10.7 Sweep Protection - A sweep protection circuit shall be provided to prevent damage to the digital image viewer in the event a sweep failure occurs.

3.3.11 Interfaces

3.3.11.1 Electrical Interface - Coaxial cables that are used to connect the digital image viewer with interfacing modules shall use female BNC terminations at each end. Cables used between the digital image viewer chassis and a remote control panel shall be 12 feet long. Cables used between the chassis and the display tube should be at least 2 feet long, with 4 feet preferred.

3.3.11.1.1 "Loop Through" Capability - The digital image viewer shall be constructed so that, if desired, any digital image viewer can be driven in series with another digital image viewer, by looping through. When "loop through" is not employed, a suitable termination shall be provided.

3.3.11.1.2 Signals - Signals provided to the digital image viewer will consist of the following:

<u>Signal</u>	<u>Description</u>	<u>Load Impedance</u>
Horizontal Drive	TBD	75 Ohms
Vertical Drive	TBD	"
Sync	TBD	"
Blanking	TBD	"
Picture Video	TBD	"

(1) Scan Lines - The digital image viewer module shall synchronize with and display the same number of scan lines (approximately 2000) as are provided by the digital image camera module.

(2) Interlace - Selectable interlace capability or an automatic interlace lock-up capability shall be supplied as follows:

(1) Non-Interlace

(2) 4:1

The addition of 2:1, 3:1, and 5:1 interlace selections or automatic lock-up shall be a design goal.

(3) Frame Rate - A frame rate of 15 frames per second shall be provided. Selectable frame rates or automatic lock-on to frame rates of 7.5, 10, and 15 frames per second, are a design goal.

(4) Analog Signals - The electrical interface of the digital image viewer module with all other modules is analog. D/A conversion, when it is performed for data link reception purposes, will take place external to this module.

3.3.11.2 Mechanical Interface - The digital image viewer chassis and power supply may be packaged for mounting in a 19" relay rack. The digital image viewer display tube shall be designed so that it can be mounted in any orientation, with no positional restrictions, and still meet all requirements of this specification. The display tube may be mounted separate from the chassis, in its own yoke. Interconnecting cables shall be sufficiently flexible and long to permit this type of mounting, if a separate tube is employed.

A rotational positioning capability that may affect mounting of the display tube is specified in 3.4.8.6.

3.3.11.3 Optical Interface - The digital image viewer should be supplied with an optically flat faceplate, to minimize the summation of distortions in an optical projection path.

3.3.12 Power Consumption - The digital image viewer module shall consume no more than 1200 watts of power.

3.3.13 Finish - The digital image viewer display tube mounting yoke shall be painted non-reflecting flat black, if the display tube is mounted separately from the chassis.

3.3.14 Display Physical Characteristics

3.3.14.1 Raster Size - In Compass Preview, the digital image viewer raster display will be optically magnified so as to appear two to four times the size that is observed when the raster is viewed directly (without the use of optical projection). The raster size shall have a 7 to 11 inch diameter. The digital image viewer module may have other applications (not specified herein) where it will be configured so as to permit direct viewing of a 10" x 10" raster. A design goal should be the ability to accommodate a change to a 10" x 10" raster with a minimum of modification of the basic design.

3.3.14.2 Phosphor - The display should be usable with either a P-38 or a P-40 phosphor. (The purchase order will specify which phosphor should be supplied.)

3.4 Performance

3.4.1 Resolution - Limiting vertical resolution shall be greater than 1500 TV lines over 80% of the display area. Horizontal and vertical average resolution shall be greater than 1800 TV lines over 50% of the display area. Average corner resolution shall be greater than 1500 TV lines.

3.4.2 Gray Scale - At least 12 gray scale steps of 0.15 density difference shall be resolved on both horizontal and vertical targets anywhere in the display area, when fed with a 15 step input signal. Resolution of 15 steps is a design goal. This gray scale capability shall be obtained while meeting the resolution specified in 3.4.1.

3.4.3 Aspect Ratio - The nominal display aspect ratio shall be circular or 1:1 (square).

3.4.4 Signal/Noise - Signal/noise shall be 30 db or better when operating with the resolution specified in 3.4.1, where:

$$\text{signal/noise} = 20 \log_{10} \left[\frac{\text{video volts (peak-to-peak)}}{\text{noise volts (root-mean-square)}} \right]$$

An improvement in signal/noise with a decrease in frame rate is a design goal.

3.4.5 Positional Error - Maximum positional error due to scanning non-linearities and other geometric distortions shall not exceed $\pm 1\%$.

3.4.6 Uniformity - Uniformity of illumination shall be 85% or better anywhere in the display area, when operating with the resolution specified in 3.4.1 and displaying all-white, all-black, and 50% gray targets.

3.4.7 Brightness - A maximum brightness of at least 50 foot lamberts is desired when using a P-40 phosphor. The requirements of 3.4.1 and 3.4.2 shall be met at a brightness of at least 25 foot lamberts, using either a P-40 or a P-38 phosphor.

3.4.8 Controls - A minimum number of controls is desired for normal operations. All frequently used controls shall be mounted on a remote control panel (see Figure 3-45, Vol. I). Adjustable controls should use multiturn high-resolution pots or similar devices that permit precision adjustment. The design of all controls shall be approved by Northrop.

3.4.8.1 On-Off - An on-off control shall be provided.

3.4.8.2 Electrical Focus - A capability shall be provided that permits the user to adjust the electrical focus so as to obtain maximum display resolution.

3.4.8.3 Brightness - A capability shall be provided that permits the user to continuously adjust the brightness from the maximum specified in 3.4.7, down to less than 1 foot lambert.

3.4.8.4 Contrast - A capability shall be provided that permits the user to continuously adjust the contrast so as to obtain a range of 0.15 density gray shades, from a minimum of five, to the maximum specified in 3.4.2.

3.4.8.5 Raster Positioning - The equipment shall incorporate the capability to continuously adjust the image display raster a minimum of $\pm 30\%$ of the raster size from center, both in the direction of scan and perpendicular to the direction of scan.

3.4.3.6 Display Orientation - The equipment shall incorporate the capability to selectively rotate the image display a minimum of $\pm 5^\circ$, with a resolution of 0.2° , while meeting all requirements of this specification. This rotation may be performed optically, electrically, or mechanically (e.g., by yoke rotation, gimbaling the display tube, or gimbaling the entire chassis).

3.4.8.7 Scale Adjustment - A capability shall be provided that permits one to continuously adjust the X and Y dimensions of the displayed raster at least $\pm 5\%$ of their nominal values. This adjustment shall affect both X and Y dimensions equally. It shall be possible to return to the nominal (non-magnified) setting of this control quickly.

3.4.8.8 Differential Scale Adjustment - A capability shall be provided that permits one to differentially adjust the X raster dimension $\pm 10\%$ with respect to the Y raster dimension, and vice versa. It shall be possible to return to the nominal (non-magnified) setting of this control quickly.

3.4.8.9 Vertical Linearity - A capability shall be provided that permits one to continuously adjust the linearity of the raster perpendicular to the scan line axis. This adjustment shall take the form of effecting a uniform changing of the spacing between adjacent scan lines, as a function of distance on the display. This will result in crowding scan lines together at the top of the display, and stretching them apart at the bottom, or vice versa. The desired stretch range is at least 10 nominal scan line spacings. It shall be possible to return to the nominal (linear) setting of this control quickly.

3.4.8.10 Horizontal Linearity - A capability shall be provided that permits one to continuously adjust the linearity of the raster in the scan direction. This adjustment shall take the form of effecting a uniform change of the speed of the horizontal sweep as a function of displacement across the display tube. This will result in crowding the picture elements together at one end of the scan, and stretching them at the other, or vice versa. The desired stretch range is at least 13 nominal picture resolution element spacings. It shall be possible to return to the nominal (linear) setting of this control quickly.

3.4.9 Jitter - Jitter shall be controlled so as to obtain the resolution specified in 3.4.1 over a 3-second period.

3.4.10 Stability - The stability of the equipment shall be such that no more than 0.25% drift occurs per 24 hours, after a 10-minute warm-up.

4.0 QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for Inspection - The Supplier is responsible for the performance of all inspection requirements as specified herein. The Supplier may use his own facilities or any commercial laboratory acceptable to Northrop. Northrop and the Government reserve the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure that the equipment conforms to the prescribed requirements.

In addition to the tests required to be performed by the Supplier, as described herein, the equipment will be subjected to further laboratory and operational tests by Northrop and the Government. These tests may include functional, environmental, and EMI tests at the subsystem and system level. The Supplier shall provide technical and logistic support for these tests as defined in the statement of work.

4.1.1 Classification of Tests - The equipment covered by this specification shall be subject to the following tests:

- (1) Design Approval Tests
 - (a) Equipment Bench Tests
- (2) Acceptance Tests
 - (a) Bench Tests
 - (b) Environmental Burn-In

4.2 Design Approval Tests - Design approval tests shall be conducted by the Supplier on one equipment unit as defined in the statement of work. Tests shall be accomplished under the approved test procedures established in 4.4. Northrop shall be advised at least 10 days prior to conducting the tests so that a Northrop and/or a Government representative can witness or supervise the tests if desired.

4.2.1 Design Approval Test Data - The Supplier shall submit all data collected in conducting these tests to Northrop for review and approval. The Supplier shall monitor the total hours of equipment operation during the tests, and furnish such data to Northrop at the time of equipment delivery.

4.2.2 Scope of Tests

4.2.2.1 Equipment Bench Tests - Bench tests should be conducted by the Supplier to demonstrate all the requirements of Section 3. The Supplier shall furnish specific test methods in the test procedures required by 4.4.

4.3 Acceptance Tests - Each equipment submitted for acceptance shall be subjected to bench tests and environmental burn-in by the Supplier. Tests shall be accomplished under the approved test procedures established in 4.4. Northrop shall be advised at least 10 days prior to conduct of the tests so that a Northrop and/or a Government representative can witness the tests when desired.

4.3.1 Acceptance Test Data - The Supplier shall submit all data collected in conducting these tests, including equipment operating times, to Northrop for review and approval.

4.3.2 Scope of Tests - Design and development acceptance tests shall be adequate to determine compliance with the requirements of material, workmanship, and functional performance and to serve as an indication of reliability.

4.3.2.1 Acceptance Bench Tests - Bench tests shall be conducted by the Supplier to demonstrate compliance with form, fit, and function requirements as defined in Section 3.

4.3.2.2 Environmental Burn-In - Each equipment to be submitted for acceptance shall be subjected to an environmental stressed burn-in for the purpose of establishing a reasonable confidence level with respect to the environmental integrity of the design and for the purpose of eliminating early life failure.

Equipment shall be cycled through all operating modes during the burn-in, allowing approximately equal operating time for each mode.

Should a failure occur, it should be repaired and the cycle started over. Should any failure (or failures) occur that indicate a design deficiency, or a repetitive component failure or defect, corrective action shall be taken to eliminate this deficiency from all units. A record shall be kept of all failures.

4.4 Test Procedures - The procedures used for conducting the Equipment Design Approval and Acceptance Tests shall be prepared by the Supplier and submitted to Northrop for review and approval.

4.5 Reconditioning of Tested Equipment - Equipment that has been subjected to Acceptance Tests shall be reconditioned by the Supplier by replacing all worn or damaged items. After reworking, the Supplier shall resubmit the equipment for Acceptance Bench Tests (4.3.2.1).

4.6 Pre-Testing - No item, part or complete equipment shall be Design Approval or Acceptance Tested by the Supplier until it has been previously operated, checked, and inspected by the Supplier and found to comply, to the best of his knowledge and believe, with all of the applicable requirements.

4.7 Rejection and Retest - Equipment which has been rejected shall have corrective action taken and shall be resubmitted for acceptance. Before resubmitting, a full account of the cause for rejection and the corrective action taken shall be furnished to Northrop.

5.0 PREPARATION FOR DELIVERY

5.1 Packaging and Shipping - The Supplier shall package and ship the equipment in accordance with best commercial practice. Marking of all packages and shipping containers shall be in accordance with MIL-STD-129.

6.0 NOTES

6.1 Performance Objectives - Simplicity of operation, ease of maintenance, good reliability, and improved performance of the specific functions beyond the requirements of this specification are design objectives. When it appears that a substantial improvement in any of these areas will result from the use of materials, parts, or processes other than those specified in this specification, their use shall be investigated. Where such investigation shows that an advantage can be realized, a request for approval shall be submitted to Northrop for consideration.

Section 6
SPECIFICATION FOR
ALPHANUMERICS AND GRAPHICS MODULE
FOR COMPASS PREVIEW

1.0 SCOPE

1.1 Scope - This specification states requirements for an alphanumeric and graphics module that will be used in Compass Preview to generate and display alphanumerics and graphics for:

- (1) Annotating projected continuous tone photographic film imagery by coincident projection of the alphanumerics and graphics.
- (2) Analog video mixing for coincident display with continuous tone imagery displayed on a digital image viewer.
- (3) Direct view on an electronic display terminal.

Either (1) and (3) or (2) and (3) can occur at the same time, with different data displayed on each.

1.2 Classification - The equipment covered by this specification shall consist of the following assemblies:

- Generators
 - Alphanumeric
 - Graphic
 - Cursor
 - Remote Generator Control Panel
- Displays
 - Projection
 - Projection Head
 - Projection Chassis
 - Remote Projection Display Control Panel
 - Direct View
- Input Devices
 - Keyboards
 - Alphabetic
 - Numeric
 - Track Ball
 - Data Pen
 - Control Panel
- Optional Assemblies
 - Power Supply(ies)
 - Buffer Memory(ies)
 - Controller

1.3 Associated Equipment - The alphanumerics and graphics module shall interface with the following associated equipment:

- Video Mixer-Switcher Module
- PDP 11/45 Computer Module
- Digital Image Viewer Module
- Viewing Module
- Digital Image Enclosure Module

2.0 APPLICABLE DOCUMENTS

2.1 General - The following documents of the issue in effect on , form a part of this specification to the extent specified herein.

SPECIFICATIONS

Military

MIL-G-45662	Calibration System Requirements
MIL-E-4158	Electronic Equipment, Ground
MIL-P-116	Preservation, Methods of

Military

MIL-STD-130	Identification Marking of U.S. Military Property
MIL-STD-150	Military Standard, Photographic Lenses
MIL-STD-195	Marking for Connection of Electrical Assemblies
MIL-STD-454	Standard General Requirement for Electronic Equipment
MIL-STD-461	Electromagnetic Interference Characteristics, Requirements for Equipment
MIL-STD-721	Definitions of Effectiveness Terms for Reliability, Maintainability, Human Factors, and Safety

STANDARDS

Military

MIL-STD-785 Requirements for Reliability Program
MIL-STD-810 Environmental Test Methods
MIL-STD-882 System Safety Program
USAX 3.4 American National Standard ASCII Symbol Set

Federal

FED-STD-102 Preservation, Packaging, and Packing

Other

AFM-66-1 Maintenance Management
MIL-HDBK-472 Maintainability Prediction

2.2 Availability of Documents - When requesting Specifications, Standards, and other publications refer to both title and number. Copies of Northrop documents required can be obtained from Northrop Corporation, Electronics Division, 1 Research Park, Palos Verdes Peninsula, California 90274. Copies of other applicable documents can be obtained from Document Engineering Company, Van Nuys, California 9405.

2.3 Precedence of Documents - When the requirements of the contract, this specification or applicable subsidiary specifications are in conflict, the following precedence shall apply:

- (1) Contract and Statement of Work - The contract and statement of work shall have precedence over this specification.
- (2) This Specification - This specification shall have precedence over the applicable documents listed herein. Any deviation from this specification, or from applicable documents, shall be specifically submitted in writing for approval by Northrop.
- (3) Applicable Documents - Applicable documents shall have precedence over subsidiary documents (those documents called out within the applicable documents).

3.0 REQUIREMENTS

3.1 Design and Development - This specification makes provision for limited design and development.

3.2 Selection of Parts, Materials, and Processes - The selection of parts, materials, and processes shall be in accordance with MIL-E-4158 and MIL-STD-454, except as specified herein.

3.2.1 Marking of Parts - Each part used in fabrication and assembly shall be marked in accordance with good commercial practice. Connectors for electrical assemblies shall be marked in accordance with MIL-STD-195.

3.3 Design and Construction

3.3.1 General - The equipment shall conform to the requirements of good commercial practice for design, construction, and workmanship, except as specified herein.

3.3.2 Modular Construction - The equipment shall use modular construction techniques to the maximum extent consistent with good design practices. All modular assemblies shall be easily replaceable to permit rapid interchange with spare modules. To the maximum extent practical, these modules shall be of the plug-in type, to allow ease of removal and replacement for service, maintenance, and repair. Where the design requires electromechanical assemblies, the electronic parts shall be so grouped and mounted as to be easily removed from the mechanical assemblies.

3.3.3 Physical Weight and Size

3.3.3.1 Total Weight - The total weight of the projection display head, separate from a free standing or rack-mountable electronics chassis, shall not exceed 180 pounds. The total weight of the direct view display shall not exceed 70 pounds.

3.3.3.2 Dimensions - Physical dimensions of the projection display head shall not exceed the following:

- (1) Height - 20"
- (2) Width - 16"
- (3) Depth - 33"

Physical dimensions of the direct view display shall not exceed:

- (1) Height - 25"
- (2) Width - 19"
- (3) Depth - 28"

If necessary, the chassis may be packaged separate from the display tube to meet this requirement, provided a remote control panel is supplied.

All other assemblies shall be packaged for 19" relay rack installation.

3.3.4 Reliability

3.3.4.1 Operational Stability - The equipment should operate with satisfactory performance, continuously or intermittently, for a period of at least 40 hours without the necessity for readjustment of any controls which are inaccessible to the operator during normal use.

3.3.4.2 Operating Life - The equipment should have a total operating life of 4,000 hours with reasonable servicing and replacement of parts.

3.3.4.3 Reliability in Terms of Mean Time Between Failures (MTBF) - The equipment should have 1,000 hours of mean operating time between failures.

3.3.5 Cabling, Connections, and Connectors - Where practical, cabling, connections, and connectors shall be in accordance with MIL-STD-195. The location of interface and test connectors shall be subject to approval by Northrop.

3.3.6 Interference Control - Electromagnetic interference should be controlled within the limits of MIL-STD-461.

3.3.6.1 Inter-Equipment Cables - All inter-equipment cables shall be designed to restrict radiation of the signal being conducted by the cable to the lowest achievable level, within the practical physical cable limitations.

3.3.7 Provisions for Maintainability

3.3.7.1 Organizational Maintainability Requirements - Fault isolation should be unambiguous through the system to the specific equipment unit.

3.3.7.2 Intermediate Maintainability Requirements - Intermediate maintenance shall be on the system element basis. Fault isolation shall be to the specific assembly. Equipment design should be such that corrective action at the intermediate maintenance level can be performed with a Mean Time to Repair (MTTR) of 1 hour.

3.3.7.3 Accessibility - Access to circuit boards for test and repair should not require realignment of optical, electromagnetic, electronic, or mechanical assemblies or subassemblies.

3.3.8 Nomenclature and Nameplates - Northrop will supply nameplate data.

3.3.9 Standard Conditions - The following conditions will be used to establish normal performance characteristics of the equipment:

Temperature:	75°F ± 20°F
Altitude:	Normal ground, -50' to +2,500'
Vibration:	None
Humidity:	5% to 90% relative humidity
Input Voltage:	117 VAC, ±10%, 60 Hz

3.3.10 Service Conditions - The equipment should be designed to meet the following environmental requirements.

3.3.10.1 Temperature - The equipment should be capable of withstanding the temperatures specified below:

- (1) Operational Range - The equipment should be designed to operate, after equipment warm-up, at temperatures from +32°F to +100°F.
- (2) Non-Operating Range
 - (a) High Temperature - The equipment should be designed to withstand high temperature storage of +160°F.
 - (b) Low Temperature - The equipment should be designed to withstand low temperature storage of -80°F.

3.3.10.2 Air Pressure Range - The equipment shall be designed to operate in a pressure range of 29.92 to 20.58 inches of mercury (sea level to 10,000'). The equipment shall withstand a storage pressure of 3.44 inches of mercury (50,000' during air transportation).

3.3.10.3 Fungus Resistance - The equipment shall be designed and constructed without the utilization of any fungus nutrient material.

3.3.10.4 Warm-Up Time - The equipment shall be designed so that full operating capability is achieved in not more than two minutes 30 seconds.

3.3.10.5 Overload Protection - All parts and circuits of the equipment which are likely to carry an overload shall withstand an overload without permanent damage to the equipment, or shall have suitable protective devices. The use of fuses or other protective devices is subject to the approval of Northrop.

3.3.10.6 Undervoltage Protection - The equipment shall not be damaged by voltages below the minimum specified herein and shall automatically return to normal operation when normal voltages are restored.

3.3.10.7 Sweep Protection - Sweep protection circuits shall be provided to prevent damage to any assembly that might experience a sweep failure.

3.3.11 Interfaces

3.3.11.1 Electrical Interface - Coaxial cables that are used to connect the interfacing modules and assemblies shall use female BNC terminations at each end.

3.3.11.1.1 "Loop Through" Capability - The displays shall be constructed so that, if desired, any display can be driven in series with another display, by looping through. When "loop through" is not employed, a suitable termination shall be provided.

3.3.11.1.2 Video Signals - Alphanumerics and graphics represented by video signals in the alphanumerics and graphics module can be extruded, or stroke or raster generated. However, when the video generated by the alphanumerics and graphics module is interfaced with the digital image viewers (via the video mixer-switcher), the video shall interface with the following supplied sync. signals:

<u>Signal</u>	<u>Description</u>	<u>Load Impedance</u>
Horizontal Drive	TBD	75 Ohms
Vertical Drive	TBD	75 Ohms
Sync	TBD	75 Ohms
Blanking	TBD	75 Ohms

(1) Scan Lines - The alphanumerics and graphics module shall provide synchronized scan lines (approximately 2000) identical to those provided by the digital image camera module.

(2) Interlace - Selectable interlace capability shall be supplied as follows:

- (1) Non-Interlace
- (2) 4:1

The addition of 2:1, 3:1, and 5:1 interlace selections shall be a design goal.

(3) Frame Rate - A frame rate of 15 frames per second shall be provided. Selectable frame rates of 7.5, 10, and 15 frames per second are a design goal.

(4) Analog Signals - The interfacing signals for video mixing shall be analog video.

3.3.11.1.3 PDP 11/45 Module Interface - The PDP 11/45 module will provide 16-bit word commands that denote type of alphanumeric or graphic, the x-y location of alphanumerics or the end points of graphics, and upon which display the alphanumeric or graphic is to be drawn. The alphanumerics and graphics module shall properly respond to these commands.

Encoded cursor positions to at least 10 bit precision, and cursor identification shall be supplied as outputs to the PDP 11/45.

Keyboard entries shall be capable of being routed to the PDP 11/45 instead of to the alphanumerics and graphics generator module, for use in PDP 11/45 data entry.

3.3.11.2 Mechanical Interface - A flat machined plate shall be provided for mounting the projection display head to the enclosure module. This plate shall have a 1/4"-20 tapped hole at each corner. The plate shall be parallel to the display head axis $\pm 0.5^\circ$ or better. The projection display head shall be designed so that it can be mounted in any orientation, with no positional restrictions, and still meet all requirements of this specification.

The direct display shall be mounted in the enclosure as shown in figure 3-39, Vol I. 1/4"-20 holes shall be provided in each of four corners for mounting. The display face shall have holes on each corner for fastening it flush with the enclosure control console.

3.3.12 Power Consumption - The alphanumerics and graphics module shall consume no more than 2000 watts of power.

3.3.13 Finish - The projection display head shall be painted nonreflecting flat black.

3.4 Performance

3.4.1 Generators - The generators may be time-shared between the projection and direct view displays.

3.4.1 Alphanumeric Generator

- (1) Size - Two sizes of alphanumeric characters shall be selectable by the user. The smaller character size shall be capable of generating the following for display: 44 rows of characters, with 64 characters in each row, for a maximum possible total of 2816 characters. The larger character size shall be 50-100% larger than the smaller size in height and width (less than 2816 characters may be displayed). Maintenance adjustment of $\pm 50\%$ of the nominal character sizes should be a design goal.
- (2) Type - The standard ASCII set of 64 alphanumeric and punctuation characters, as defined in USAX 3.4, shall be supplied. Provision for ten additional user programmable symbols should be a design goal.

- (3) Font - A single, upper case, easy to read, font, without serifs, shall be generated.
- (4) Character Enhancement - A selective capability to invert by character, outline a bright (white) character with a dark outline on one edge, or suppress picture video background in the vicinity of the character shall be provided. (These annotations will be mixed with continuous-tone video imagery in the digital image viewer, in one mode of operation. Enhancement is required with some backgrounds in order to improve readability.)
- (5) Character Blink - A selective capability to rapidly blink a character, as well as a group of characters, shall be provided.
- (6) Matrix Size - If alphanumeric characters are generated from a matrix, that matrix shall be at least 7 x 9 elements.
- (7) Character Width and Brightness - Apparent character width and brightness shall be a constant for every line segment, and from segment to segment.
- (8) Typewriter Mode - A fixed format typewriter mode, with space and backspace, forward and reverse line feed, and carriage return, shall be supplied.
- (9) Editing - Selective deletion of a single character, or a group of characters all on one line (not necessarily the entire line) shall be possible.
- (10) Speed - No more than 4 seconds shall be required to erase a previous 2816 character display, and replace it with a new 2816 character display. This requirement may be met sequentially rather than simultaneously for the projection display and the direct view display.

3.4.1.2

Graphics Generators

- (1) Types - Straight line and circle generators shall be provided. Curved arc generators may be used if they improve performance without substantially increasing price.
- (2) Positioning - It shall be possible to position the end points of a vector anywhere in a 1024 x 1024 matrix. A 2048 x 2048 matrix capability is desired if it can be obtained at little additional cost. A 512 x 512 matrix is permissible, with the direct view display only.

- (3) Line Widths - Narrow and wide line widths shall be supplied.
- (4) Speed - It shall be possible to construct vectors at a rate of at least 200 inches per second.
- (5) Circle Sizes - A capability to select, for automatic construction, at least 63 different size circles, with the origin located anywhere within the matrix specified in (2) above, shall be provided. The maximum circle diameter should be approximately the size of the largest circle that can be inscribed in the respective direct view and projection display rasters.

3.4.1.3

Cursor Generators

- (1) Types - A typing cursor, and a vector end point cursor shall be generated, simultaneously if desired.
- (2) Shape Modification - A design goal shall be to permit the user to permanently change the shape of the vector end point cursor. (It would be desirable to have this capability be implemented with software. However, hardware implementation is acceptable.)
- (3) Positioning - The typing cursor shall be positioned by the normal typing controls within the typing format specified in 3.4.1.1(8). The vector end point cursor shall be positioned anywhere within the matrix of 3.4.1.2(2), using either the trackball, the data pen, or both sequentially.
- (4) Permanence - The cursors shall be only as permanent as the persistence of the display. Cursors shall not cause permanent destruction of any data on either display or in any total display buffer memory(ies).

3.4.1.4

Remote Generator Control Panel - The following controls shall be supplied in a remote generator control panel (see Figure 3-39, Vol. I). This panel may be made a part of other control panels specified herein. The design of this panel shall be approved by Northrop prior to fabrication. 15 feet of interconnecting cable shall be provided between this panel and the associated controlled assemblies.

- (1) On-Off - A master power on-off control shall be provided.
- (2) Reset - A reset control shall be provided.

Activation of this control shall cause the selected display to be erased and cause both cursors to return to an upper left home position. (A possible change in raster orientation for the projection display will be supplied later, if necessary.)

- (3) Character Size - A character size selector shall be provided.
- (4) Line Width - A two position vector line width selector shall be provided.
- (5) Character Enhancement - An enhancement on-off selector shall be provided.
- (6) Character Blink - A blink on-off selector shall be provided.
- (7) Character Edit - A character edit control shall be provided.
- (8) Line Edit - A line edit control shall be provided.
- (9) Circle Origin - A control shall be provided to enable the circle function routine.
- (10) Circle Size - A point on the circle circumference may be indicated with the data pen. Alternately, selector(s) should be provided that permit the user to select circle size.
- (11) Cursor Assignment - A control shall be provided that permits the user to select which one of the two displays (specified in 3.4.2) the cursors will be active on.
- (12) Draw Vector - A control shall be provided that causes a vector to be displayed that connects the vector end point cursor with the last vector termination, or the first positioning of the vector end point cursor.

3.4.2 Displays

3.4.2.1 Projection Display - The projection display shall be provided with its own optics. All requirements specified herein (except as otherwise noted) are for performance of the projected display just prior to imaging on a rear-projection screen or viewing module.

- (1) Throw Distance - The distance between the projection lens exit pupil and the image plane shall be 83.25 inches.

- (2) f - Number - The f-number of the projection lens should be approximately f-1.
- (3) Field of View - At the throw distance specified in (1), the field of view shall be 24 ± 1 inches in diameter.
- (4) Resolution - All alphanumerics and graphics shall be clearly legible when projected as specified in (1), (2) and (3), above. If scan lines are used (as opposed to stroke writing), both the horizontal and vertical limiting resolution shall exceed 700 TV lines.
- (5) Brightness - Brightness shall be at least 30 foot lamberts at the throw distance specified in (1) above, measured without a projection screen.
- (6) Polarity - Bright alphanumerics and graphics shall be displayed on a dark background.
- (7) Contrast - Contrast shall be at least 15, when viewed with a high gain rear projection screen with 8 foot candles of incident illumination. This specification shall be met at any position on the screen. Contrast is defined as follows:

$$\text{Contrast} = \frac{\text{Brightness of character}}{\text{Brightness of background}}$$

- (8) Brightness Uniformity - The ratio of the brightest to the dimmest character shall not be greater than 1.5.
- (9) Aspect Ratio - The display aspect ratio shall be circular, or 1:1 (square). When projected, this aspect ratio shall have the field of view, specified in (3) above, inscribed within it (i.e., the aspect ratio shall cause the field of view to be filled.)
- (10) Positional Error - Maximum positional error due to optical distortions, scanning non-linearities, and other geometric distortions shall not exceed 2%.
- (11) Size Uniformity - Character size shall not vary more than $\pm 5\%$ of character height at any location on the display.
- (12) Jitter - Jitter shall be controlled to less than 20% of the thickness of a small character line width.

- (13) Stability - The stability of the equipment shall be such that no more than 0.25% drift occurs per 24 hours, after a 10 minute warmup.
- (14) Display Color - A distinctive, non-white filter or phosphor color shall be supplied. Green is preferred.
- (15) Flicker and Persistence - A display persistence and refresh rate combination shall be selected that makes flicker unnoticeable at the maximum brightness specified in (5) above, in an 8 foot candle ambient. However, the combination of persistence and refresh rate shall permit the complete change of a maximum character display, as defined in 3.4.1.1(10), in the time noted in 3.4.1.1(10). The combination of persistence and refresh rate shall also permit erasure and display of 200 inches of vector in one second.
- (16) Controls - A minimum number of controls is desired for normal operation. The following controls shall be supplied on a remote control panel (see Figure 3-45, Vol. I). This panel may be made a part of other control panels specified herein. Adjustable controls should use multicurn high-resolution pots or similar devices that permit precision adjustment. The design of this panel shall be approved by Northrop prior to fabrication. 15 feet of interconnecting cable shall be provided between the panel and the associated controlled assemblies.
- (a) On-Off - A power on-off switch shall be provided.
 - (b) Standby - A standby switch should be provided if it permits more rapid warmup and prolonged life of the display.
 - (c) Electrical Focus - A capability shall be provided that permits the user to adjust the electrical focus so as to obtain maximum display resolution.
 - (d) Brightness - A capability shall be provided that permits the user to adjust the electrical focus so as to obtain maximum display resolution.

(e) Other Adjustments - Other adjustments shall be provided as required so that the display can meet the requirements of this specification, e.g.:

- Contrast
- Optical Focus
- Raster Centering
- Horizontal and Vertical Size
- Horizontal and Vertical Linearity

Recommendations as to the need to remote these adjustments as well as other adjustments not called out above, shall be supplied to Northrop.

3.4.2.2

Direct View Display

- (1) Display Size - The display size shall be approximately 10" x 10".
- (2) Resolution - All alphanumerics and graphics shall be clearly legible when viewed by the user at any distance from 14 to 36 inches away. If scan lines are used (as opposed to stroke or dot matrix writing, both the horizontal and vertical limiting resolution shall exceed 700 TV lines.
- (3) Brightness - Brightness shall be at least 50 foot lamberts.
- (4) Polarity - Bright alphanumerics and graphics shall be displayed on a dark background.
- (5) Contrast - Contrast shall be at least 15, when viewed in 8 foot candles of incident illumination. This specification shall be met at any position on the display. Contrast is defined as follows:

$$\text{Contrast} = \frac{\text{Brightness of Character}}{\text{Brightness of Background}}$$

- (6) Brightness Uniformity - The ratio of the brightest to the dimmest character shall not be greater than 1.5.
- (7) Aspect Ratio - The display aspect ratio shall be 1:1 (square).
- (8) Size Uniformity - Character size shall not vary more than $\pm 5\%$ of character height at any location on the display.

- (9) Positional Error - Maximum positional error due to scanning non-linearities and other geometric distortions shall not exceed 2%.
- (10) Jitter - Jitter shall be controlled to less than 20% of the thickness of a small character line width.
- (11) Stability - The stability of the equipment shall be such that no more than 0.25% drift occurs per 24 hours, after a 10-minute warmup.
- (12) Flicker and Persistence - A combination of phosphor persistence and refresh rate shall be selected that makes flicker unnoticeable at the maximum brightness specified in (3) above, in an 8 foot lambert ambient. However, the combination of persistence and refresh rate shall permit the complete change of a maximum character display, as defined in 3.4.1.1(10), in the time noted in 3.4.1.1(10).
- (13) Controls - A minimum number of controls is desired for normal operations. All frequently used controls shall be readily accessible on the front of the display (see Figure 3-45*). Adjustable controls should use multi-turn high-resolution pots or similar devices that permit precision adjustment. The design of these controls shall be approved by Northrop.
- (a) On-Off - An on-off control shall be provided.
- (b) Electrical Focus - A capability should be provided that permits the user to adjust the electrical focus so as to obtain maximum display resolution.
- (c) Brightness - A capability shall be provided that permits the user to continuously adjust the brightness from the maximum specified in (3) above, down to less than 1 foot-lambert.
- (d) Other Adjustments - Other adjustments shall be provided as required so that the display can meet the requirements of this specification, e.g.:
- Contrast
 - Raster Centering
 - Horizontal and Vertical Size
 - Horizontal and Vertical Linearity

3.4.3 Input Devices

3.4.3.1 Keyboards

- (1) Alphabetic Keyboard - An alphabetic keyboard with format in standard typewriter or teletypewriter format shall be provided. Key markings shall correspond to the symbol set called out in 3.4.1.1(2) (with blank keys for programmable symbols, if provided.) In addition, keys shall be supplied to satisfy the typewriter mode requirement of 3.4.1.1(8), e.g.: carriage return, space, backspace, and forward and reverse line feed. These keys shall control the positioning of the typing cursor specified in 3.4.1.3.
- (2) Numeric Keyboard - The numerals 0 through 9 shall be marked on keys arranged in a standard calculator numeric pattern.
- (3) Coding - Character codes shall conform to ASCII recommendations, since these keyboards may also be used to input data to the PDP 11/45.
- (4) Spacing - Alphabetic and numeric key spacing shall be on nominal 0.75" centers.
- (5) Keyboard Type - Solid state, "coffee-proof" keys shall be employed.

3.4.3.2 Track Ball - A track ball control shall be provided that gives the user the capability to position the vector end point cursor specified in 3.4.1.3, to the resolution specified in 3.4.1.3. The cursor positioning servo loop shall be closed via the user's observance of the actual cursor position on the display. A capability shall be provided that permits the user to disable either the "x" or the "y" output of the track ball. The track ball shall operate independently of the data pen, or in conjunction with it, as desired by the user.

3.4.3.3 Data Pen - A data pen shall be provided that has the capability of positioning the vector end point cursor specified in 3.4.1.3, as well as being used for menu selection. The pen may also be used for symbol "hooking" and circle size indication. The cursor positioning servo loop shall be closed via the user's observance of the actual cursor position on the display. The data pen shall operate independently of the track ball, or in conjunction with it, as desired by the user.

- (1) Type - The data pen shall permit free hand position indication on either the projection display or the direct view display. In order to minimize hand restrictions, the pen shall have no more than one small cable extending from it. Wheeled "mouse" type devices shall not be employed. The pen shall operate

in conjunction with a clear glass plate over each display. The glass plate shall not degrade resolution. The data pen shall not be dependent upon the sensing of a scanning raster or light energy for its proper operation. The design or selection of the data pen shall be approved by Northrop.

- (2) Resolution - 1024 x 1024 element data pen resolution shall be provided on either display. A design goal shall be to provide 2048 x 2048 element resolution on the projection display, if similar resolution is provided for cursor positioning.

3.4.3.4 Control Panel - A control panel shall be provided that mounts the track ball, keyboards and data pen connector and holder (see Figure 3-45, Vol. I). This control panel may be integrated with other control panels specified herein. The design of this control panel shall be approved by Northrop prior to fabrication.

3.4.4 Optional Assemblies - The following assemblies should be supplied if necessary for proper operation of the alphanumeric and graphic module:

- Power Supply(ies)
- Buffer Memory(ies)
- Controller

3.4.4.1 Buffer Memory - Two buffer memories may be required to refresh the direct view display and the projection display. (Each display can have its own independent data.)

3.4.4.2 Controller - A controller may be required to load buffer memories, generate functions, and interface the alphanumerics and graphics module with the Compass Preview PDP 11/45 computer module.

4.0 QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for Inspection - The Supplier is responsible for the performance of all inspection requirements as specified herein. The Supplier may use his own facilities or any commercial laboratory acceptable to Northrop. Northrop and the Government reserve the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure that the equipment conforms to the prescribed requirements.

In addition to the tests required to be performed by the Supplier, as described herein, the equipment will be subjected to further laboratory and operational tests by Northrop and the Government. These tests may include functional, environmental, and EMI tests at the subsystem and system level. The Supplier shall provide technical and logistic support for these tests as defined in the statement of work.

4.1.1 Classification of Tests - The equipment covered by this specification shall be subject to the following tests:

- (1) Design Approval Tests
 - (a) Equipment Bench Tests
- (2) Acceptance Tests
 - (a) Bench Tests
 - (b) Environmental Burn-In

4.2 Design Approval Tests - Design approval tests shall be conducted by the Supplier on one equipment unit as defined in the statement of work. Tests shall be accomplished under the approved test procedures established in 4.4. Northrop shall be advised at least 10 days prior to conducting the tests so that a Northrop and/or a Government representative can witness or supervise the tests if desired.

4.2.1 Design Approval Test Data - The Supplier shall submit all data collected in conducting these tests to Northrop for review and approval. The Supplier shall monitor the total hours of equipment operation during the tests, and furnish such data to Northrop at the time of equipment delivery.

4.2.2 Scope of Tests

4.2.2.1 Equipment Bench Tests - Bench tests should be conducted by the Supplier to demonstrate the requirements of Section 3. The Supplier shall furnish specific test methods in the test procedures required by 4.4.

4.3 Acceptance Tests - Each equipment submitted for acceptance shall be subjected to bench tests and environmental burn-in by the Supplier. Tests shall be accomplished under the approved test procedures established in 4.4. Northrop shall be advised at least 10 days prior to conduct of the tests so that a Northrop and/or a Government representative can witness the tests when desired.

4.3.1 Acceptance Test Data - The Supplier shall submit all data collected in conducting these tests, including equipment operating times, to Northrop for review and approval.

4.3.2 Scope of Tests - Design and development acceptance tests shall be adequate to determine compliance with the requirements of material, workmanship, and functional performance and to serve as an indication of reliability

4.3.2.1 Acceptance Bench Tests - Bench tests shall be conducted by the Supplier to demonstrate compliance with form, fit, and function requirements as defined in Section 3.

4.3.2.2 Environmental Burn-In - Each equipment to be submitted for acceptance shall be subjected to an environmental stressed burn-in for the purpose of establishing a reasonable confidence level with respect to the environmental integrity of the design and for the purpose of eliminating early life failure.

Equipment shall be cycled through all operating modes during the burn-in, allowing approximately equal operating time for each mode.

Should a failure occur, it should be repaired and the cycle started over. Should any failure (or failures) occur that indicate a design deficiency, or a repetitive component failure or defect, corrective action shall be taken to eliminate this deficiency from all units. A record shall be kept of all failures.

4.4 Test Procedures - The procedures used for conducting the Equipment Design Approval and Acceptance Tests shall be prepared by the Supplier and submitted to Northrop for review and approval.

4.5 Reconditioning of Tested Equipment - Equipment that has been subjected to Acceptance Tests shall be reconditioned by the Supplier by replacing all worn or damaged items. After reworking, the Supplier shall resubmit the equipment for Acceptance Bench Tests (4.3.2.1).

4.6 Pre-Testing - No item, part, or complete equipment shall be Design Approval or Acceptance Tested by the Supplier until it has been previously operated, checked, and inspected by the Supplier and found to comply, to the best of his knowledge and belief, with all of the applicable requirements.

4.7 Rejection and Retest - Equipment which has been rejected shall have corrective action taken and shall be resubmitted for acceptance. Before resubmitting, a full account of the cause for rejection and the corrective action taken shall be furnished to Northrop.

5.0 PREPARATION FOR DELIVERY

5.1 Packaging and Shipping - The Supplier shall package and ship the equipment in accordance with best commercial practice. Marking of all packages and shipping containers shall be in accordance with MIL-STD-129.

6.0 NOTES

6.1 Performance Objectives - Simplicity of operation, ease of maintenance, good reliability, and improved performance of the specific functions beyond the requirements of this specification are design objectives. When it appears that a substantial improvement in any of these areas will result from the use of materials, parts, or processes other than those specified in this specification, their use shall be investigated. Where such investigation shows that an advantage can be realized, a request for approval shall be submitted to Northrop for consideration.

Section 7

SPECIFICATION FOR A
FILM TRANSPORT MODULE
FOR COMPASS PREVIEW

1.0 SCOPE

1.1 Scope - This specification states requirements for a film transport module that has the capability of rapidly moving and precisely positioning photographic film with an absolute minimum degradation of the film. The moving and positioning functions can be performed under manual or computer control.

1.2 Classification - The equipment covered by this specification shall consist of the following assemblies:

- Film Transport
- Power & Control Electronics

1.3 Associated Equipment - The Film Transport Module shall interface with the following associated equipment:

- Control Panel
- System Processor Module

2.0 APPLICABLE DOCUMENTS

2.1 General - The following documents, of the issue in effect on , form a part of this specification to the extent specified herein.

SPECIFICATIONS

Military

MIL-E-4158 Electronic Equipment, Ground

Northrop

500-1 Northrop Quality Control Specification

Redwitz Research Corp.

RRC 741410 Spool, Arial Film

STANDARDS

Military

MIL-STD-130 Identification Marking of U. S. Military Property

MIL-STD-195 Marking for Connection of Electrical Assemblies

MIL-STD-454 Standard General Requirement for Electronic Equipment

MIL-STD-461 Electromagnetic Interference Characteristics, Requirements for Equipment

MIL-STD-749 Preparation and Submission of Data for Approval of Non-Standard Electronic Parts

2.2 Availability of Documents - When requesting Specifications, Standards, and other publications refer to both title and number. Copies of Northrop and Redwitz Research Corp. documents required can be obtained from Northrop Corporation, Electronics Division, 1 Research Park, Palos Verdes Peninsula, California 90274. Copies of other applicable documents can be obtained from Document Engineering Company, Van Nuys, California 91405.

2.3 Precedence of Documents - When the requirements of the contract, this specification or applicable subsidiary specifications are in conflict, the following precedence shall apply:

- (1) Contract and Statement of Work - The contract and statement of work shall have precedence over this specification.
- (2) This Specification - This specification shall have precedence over the applicable documents listed herein. Any deviation from this specification, or from applicable documents, shall be specifically submitted in writing for approval by Northrop.
- (3) Applicable Documents - Applicable documents shall have precedence over subsidiary documents (those documents called out within the applicable documents).

3.0 REQUIREMENTS

3.1 Design and Development - This specification makes provision for limited design and development.

3.2 Selection of Parts, Materials, and Processes - The selection of parts, materials, and processes shall be in accordance with MIL-E-4158 and MIL-STD-454, except as specified herein.

3.2.1 Marking of Parts - Each part used in fabrication and assembly shall be marked in accordance with good commercial practice. Connectors for electrical assemblies shall be marked in accordance with MIL-STD-195.

3.3 Design and Construction

3.3.1 General - The film transport shall conform to the requirements of sound commercial practice for design, construction and workmanship.

3.3.2 Modular Construction - The film transport shall exhibit modular construction techniques to the maximum practical extent. Modular subassemblies shall be replaceable without major disassembly of main structural components. Whenever practical, electrical components of modular subassemblies shall terminate in plug-in type connectors or spade-type terminals to allow ease of removal and replacement for service, maintenance, or repair.

3.3.3 Weight - The total weight of the film transport assembly, less guide rods, structural supports and mounting devices, and the power and control electronics, shall not exceed 125 pounds. The weight of power and control electronics package shall not exceed 95 pounds.

3.3.4 Reliability

3.3.4.1 Operational Stability - The equipment shall operate with satisfactory performance, continuously or intermittently, for a period of at least 40 hours without the necessary for readjustment of any controls which are inaccessible to the operator during normal use.

3.3.4.2 Operating Life - The equipment should have a total operating life of 4,000 hours with reasonable servicing and replacement of parts.

3.3.4.3 Reliability in Terms of Mean Time Between Failures(MTBF) - The equipment should have 500 hours of mean operating time between failures.

3.3.5 Cabling, Connections, and Connectors - Cabling, connections, and connectors shall be in accordance with MIL-STD-195. The location of interface and test connectors shall be subject to approval by Northrop.

3.3.6 Interference Control - Electromagnetic interference shall be controlled within the limits of MIL-STD-461A.

3.3.6.1 Inter-Equipment Cables - All inter-equipment cables shall be designed to restrict radiation of the signal being conducted by the cable to the lowest achievable level, within the practical physical cable limitations.

3.3.7 Provisions for Maintainability

3.3.7.1 Organizational Maintainability Requirements - Fault isolation shall be unambiguous through the system to the specific equipment unit.

3.3.7.2 Intermediate Maintainability Requirements - Intermediate maintenance shall be on the system element basis. Fault isolation shall be to the specific assembly. Equipment design shall be such that corrective action at the intermediate maintenance level can be performed with a Mean Time to Repair (MTTR) of 1 hour.

3.3.7.3 Accessibility - Access to circuit boards for test and repair should not require realignment of optical, electromagnetic, electronic, or mechanical assemblies or subassemblies.

3.3.8 Nomenclature and Nameplates - Northrop will supply nameplate data.

3.3.9 Standard Conditions - The following conditions will be used to establish performance characteristics of the equipment:

Temperature	75°F ±20°F
Altitude	-50' to +2,500'
Vibration	None
Humidity	90% Relative, Max.
Input Voltage	117 VAC +10 VAC, 60 Hz

3.3.10 Service Conditions - The equipment should be designed to meet the following environmental requirements.

3.3.10.1 Temperature - The equipment should be capable of withstanding the temperatures specified below:

(1) Operational Range - The equipment should be designed to operate, after equipment warm-up, at temperatures from +32°F to +100°F.

(2) Non-Operating Range -

(a) High-Temperature - the equipment should be designed to withstand high temperature storage of +165°F.

(b) Low Temperature - The equipment should be designed to withstand low temperature storage of -10°F.

3.3.10.2 Air Pressure Range - The equipment shall be designed to operate in a pressure range of 29.92 to 20.58 inches of mercury (sea level to 10,000'). The equipment shall withstand a storage pressure of 3.44 inches of mercury (50,000' during air transportation).

3.3.10.3 Fungus Resistance - The equipment shall be designed and constructed without the utilization of any fungus nutrient material.

3.3.10.4 Warm-Up Time - The equipment shall be designed so that full operating capability is achieved in not more than two minutes 30 seconds.

3.3.10.5 Overload Protection - All parts and circuits of the equipment which are likely to carry an overload shall withstand an overload without permanent damage to the equipment, or shall have suitable protective devices. The use of fuses or other protective devices is subject to the approval of Northrop.

3.3.10.6 Undervoltage Protection - The equipment shall not be damaged by voltages below the minimum specified herein and shall automatically return to normal operation when normal voltages are restored.

3.3.11 Physical Dimensions - Physical dimensions of the Film Transport Module shall be as follows:

- Film Transport Assembly - 37 inches long x 33 inches wide x 15 inches high.
- Power and Control Electronics - 24 inches long x 24 inches wide x 20 inches high.

3.3.12 Interfaces

3.3.12.1 Mechanical Interface - The Film Transport Module shall conform to the envelope size and shall be equipped with mounting provisions compatible with the overall system.

3.3.12.2 Electrical Interface - The Film Transport Module shall be capable of receiving and executing the following command signals:

High Speed Mode

- Direction - OV (FWD) or +5 V DC (Rev)
- 10 in./sec
- 50 in./sec +5 V DC (Discrete)
- 100 in./sec

Incremental Mode

- Direction - OV (FWD) or +5 V DC (REV)
- Run/Standby Command - 0 or 1
- Clock Pulse - 200 to 5000 Pulses per Second

Rewind Mode

- Direction - +5 V DC
- Velocity - +5 V DC (Maximum)

Occluder State and Rotation

Feedback signals shall be provided for the following functions:

- Search Mode
 - Frame Count
 - Spool Revolution Count
 - End-of-Film Indication

- Incremental Mode
 - Direction
 - Steps (.001 in./step) from "0" Ref.
 - Transverse Direction Steps (.001 in./step)
- Broken Film (Loss of Tension)
- Occluder State and Rotation

3.3.12.3 Illumination Module Interface - The illumination module shall illuminate the film in the film gate.

3.3.12.4 Control Panel Interface - The control panel shall provide manual mode selection and control of the film transport.

3.3.12.5 Photographic Film Input - The film transport shall accommodate all films with the following characteristics:

- (1) Film Widths - 35mm, 70mm, 5 inch, 6.6 inch and 9-1/2 inch roll film, and cut film up to 4-3/4" x 7-1/2".
- (2) Film Thicknesses - Base thicknesses of 1.5 to 5.2 mils (this does not include emulsion, gel backing, and other film coatings).
- (3) Film Roll Capacity - The nominal film roll capacity shall be a minimum of 500 feet of 5.2 mil film.
- (4) Base Materials - Both acetate and polyester bases shall be accommodated.
- (5) Film Spools - The film spools that are employed shall be as follows:
 - RRC 721410-1 for film widths from 35 mm to 5.0 in. wide
 - RRC 721410-3 for film widths from 5.1 in. to 7.0 in. wide
 - RRC 721410-5 for film widths from 7.1 in. to 9.5 in. wide

3.3.12.6 Zoom Projection Module Interface - The interface between the film transport module and the zoom projection module shall be via a roll film gate and a chip film gate.

- (a) Roll Film Gate - The roll film gate shall perform the final incremental adjustment to the film plane, thereby insuring sharp, uniform focus over the entire format. The film gate shall employ air to push the film away from the gate during high speed translation. However, during low speed scanning and when the film is stopped for detailed examination, the flow of air shall be reversed and the film shall be clamped to the edges of the gate.

The film gate shall be a clear aperture in a horizontal plane of at least 4.5 in. x 9.0 in. No glass platens or other double-sided constraint devices shall be used to provide the following film flatness values over the following areas:

±.001 in. (0.025 mm) over 0.28 in. (7 mm) dia.

±.010 in. (0.25 mm) over 1.25 in. (32 mm) dia.

±.080 in. (2.00 mm) over 4.50 in. (114 mm) dia. and up.

- (b) Chip Film Gate - It shall be possible to easily and rapidly load two 4-3/4" x 7-1/2" chips in one chip film gate. Glass platens may be used to make the chip film gate. The chip film gate shall provide the flatness values specified in (a) above.

3.3.13 Power Consumption - The power consumption of the Film Transport Module shall not exceed 750 watts.

3.4 Performance

3.4.1 Overall Design Concept - The film transport shall employ an advanced concept in film handling that minimizes contact and subsequent film damage. The film path shall be a single straight line from the supply spool to the take-up spool. The Film Transport Module shall handle and transport film from spool to spool at designated speeds without requiring any physical contact with either guiding or film sensing devices. The only contact the film shall be subjected to is film-on-film (as in winding on spool) and contact with film spool flanges with one edge only. No double-sided constraining of film shall be used at any point of the film between the tangent points of the film spools. (No guide rollers shall be used.) The film between the spools that forms the image plane shall be kept at the same location in space regardless of the amount of film that remains on the spools, by moving the spools independent of the rest of the transport, using commands from a film plane position detector.

3.4.2 Types of Transports - Two types of transports shall be provided that are identical in all respects except that one type will, and one type will not, have a film chip capability; and the type without a film chip capability must operate inverted.

3.4.3 Film Loading - The loading of roll film onto the film transport module shall take no more than 30 seconds, and shall be as easy as practical.

3.4.4 Roll Film Translation - The film transport shall provide the following bi-directional speed ranges for roll film translation along the film length:

- (1) Rewind - for widths to 7.0 in.: 100 in./sec min.
- (2) Rewind - for widths above 7.0: 75 in./sec minimum
- (3) Fast Forward/Reverse - Computer Control - 3 ranges consisting of 10, 50, and 100 in./sec.
- (4) Fast Forward/Reverse - Manual Control - Variable from 1.5 to 100 in./sec < 7.0 in. wide
1.5 to 75 in./sec > 7.0 in. wide
- (5) Incremental - Computer and Manual Control - Variable from 0.001 to 5.000 in./sec.

3.4.5 Chip Positioning - Positioning of the chip in the 7-1/2" dimension shall be manually controlled at a variable selectable rate, from 0.001 to 5.000 in/sec. It shall be possible to control the positioning of a chip anywhere within a 7-1/2" length.

3.4.6 Transverse Positioning Speed - Transverse positioning of the transport shall be provided. The positioning shall also move the roll film or chip in the direction of its width. This positioning shall be under either computer or manual control, at a variable selectable rate from 0.001 to 5.000 in/sec. Positioning shall be possible anywhere across an entire 9-1/2" wide roll film or a 4-3/4" wide film chip.

3.4.7 Stopping and Image Positioning - The capability of rapidly stopping at any predetermined location on roll film shall be provided. No creep shall occur after a stop. The final positioning of the image in the center of the film gate (which shall coincide with the optical axis) shall be accomplished in at least 5 seconds after the edge of frame has been located. Positioning shall be accomplished with a precision of ± 0.1 inch of actual commanded location.

3.4.8 Frame Detection - The transport shall have a capability to detect the edge of a frame of imagery when operating in either direction.

3.4.9 Film Tensioning - The film transport shall be equipped with a positive control that enables the operator to select film tension equal to 80 PSI \pm 20 PSI stress for all film widths, thicknesses, and base materials.

3.4.10 Chip Loading - Automatic transverse positioning of the transport, for both chip loading and chip display, shall be provided.

3.4.11 Occluder - An occluder shall be provided to mask one-half of the roll or chip film gate, for comparison viewing purposes. A design goal shall be a capability to rotate this occluder in synchronism with the image rotation prism of the zoom projection module.

4.0 QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for Inspection - Unless otherwise specified in the contract, the supplier shall conduct a quality assurance program which is compatible with Northrop Quality Control Specification 500-1. This document shall be effective for the duration of the contract. The Supplier is responsible for the performance of all inspection requirements as specified herein. The Supplier may use his own facilities or any commercial laboratory acceptable to Northrop. Northrop and the Government reserve the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure that the equipment conforms to the prescribed requirements.

In addition to the tests required to be performed by the Supplier, as described herein, the equipment will be subjected to further laboratory and operational tests by Northrop and the Government. These tests will include functional, environmental, and EMI tests at the subsystem and system level. The Supplier shall provide technical and logistic support for these tests as defined in the statement of work.

4.1.1 Classification of Tests - The equipment covered by this specification shall be subject to the following tests:

- (1) Design Approval Tests
 - (a) Equipment Bench Tests
- (2) Acceptance Tests
 - (a) Bench Tests
 - (b) Environmental Burn-In

4.2 Design Approval Tests - Design approval tests shall be conducted by the Supplier on one equipment unit as defined in the statement of work. Tests shall be accomplished under the approved test procedures established in 4.4. Northrop shall be advised at least 10 days prior to conducting the tests so that a Northrop and/or a Government representative can witness or supervise the tests if desired.

4.2.1 Design Approval Test Data - The Supplier shall submit all data collected in conducting these tests to Northrop for review and approval. The Supplier shall monitor the total hours of equipment operation during the tests, and furnish such data to Northrop at the time of equipment delivery.

4.2.2 Scope of Tests

4.2.2.1 Equipment Bench Tests - Bench tests shall be conducted by the Supplier to demonstrate all the requirements of Section 3 (except 3.3.6 and 3.3.10). The Supplier shall furnish specific test methods in the test procedures required by 4.4.

4.3 Acceptance Tests - Each equipment submitted for acceptance shall be subjected to bench tests and environmental burn-in by the Supplier. Tests shall be accomplished under the approved test procedures established in 4.4. Northrop shall be advised at least 10 days prior to conduct of the tests so that a Northrop and/or a Government representative can witness the tests when desired.

4.3.1 Acceptance Test Data - The Supplier shall submit all data collected in conducting these tests, including equipment operating times, to Northrop for review and approval.

4.3.2 Scope of Tests - Design and development acceptance tests shall be adequate to determine compliance with the requirements of material, workmanship, and functional performance and to serve as an indication of reliability.

4.3.2.1 Acceptance Bench Tests - Bench tests shall be conducted by the Supplier to demonstrate compliance with form, fit, and function requirements as defined in Section 3.

4.3.2.2 Environmental Burn-In - Each equipment to be submitted for acceptance shall be subjected to an environmental stressed burn-in for the purpose of establishing a reasonable confidence level with respect to the environmental integrity of the design and for the purpose of eliminating early life failure.

Equipment shall be cycled through all operating modes during the burn-in, allowing approximately equal operating time for each mode.

Should a failure occur, it should be repaired and the cycle started over. Should any failure (or failures) occur that indicate a design deficiency, or a repetitive component failure or defect, corrective action shall be taken to eliminate this deficiency from all units. A record shall be kept of all failures.

4.4 Test Procedures - The procedures used for conducting the Equipment Design Approval and Acceptance Tests shall be prepared by the Supplier and submitted to Northrop for review and approval.

4.5 Reconditioning of Tested Equipment - Equipment that has been subjected to Acceptance tests shall be reconditioned by the Supplier by replacing all worn or damaged items. After reworking, the Supplier shall re-submit the equipment for Acceptance Bench Tests (4.3.2.1).

4.6 Pre-Testing - No item, part, or complete equipment shall be Design Approved or Acceptance Tested by the Supplier until it has been previously operated, checked, and inspected by the Supplier and found to comply, to the best of his knowledge and belief, with all of the applicable requirements.

4.7 Rejection and Retest - Equipment which has been rejected shall have corrective action taken and shall be resubmitted for acceptance. Before resubmitting, a full account of the cause for rejection and the corrective action taken shall be furnished to Northrop.

5.0 PREPARATION FOR DELIVERY

5.1 Packaging and Shipping - The Supplier shall package and ship the equipment in accordance with best commercial practice. Marking of all packages and shipping containers shall be in accordance with MIL-STD-130C.

6.0 NOTES

6.1 Performance Objectives - Simplicity of operation, ease of maintenance, good reliability, and improved performance of the specific functions beyond the requirements of this specification are design objectives. When it appears that a substantial improvement in any of these areas will result from the use of materials, parts, or processes other than those specified in this specification, their use shall be investigated. When such investigation shows that an advantage can be realized, a request for approval shall be submitted to Northrop for consideration.

Section 8

SPECIFICATION FOR A
5X TO 100X ZOOM PROJECTION LENS
FOR COMPASS PREVIEW

SPECIFICATION FOR 5X TO 100X ZOOM PROJECTION LENS

Element	R1	R2	I	CA1	CA2	Row 200-001 Glass
1	10.4662	5.1097	0.2500	2.9286	2.8174	LAK8
2	513.0978	-3.1625	0.2500	2.8094	2.7944	752.305
3	-3.1625	8.9737	0.2500	2.7944	2.7186	LAK8
4	INF	INF	1.2500			BK7
5	-30.8406	5.6940	12.7500	2.7491	2.9726	
6	5.6940	-9.3354	7.0719*1			SP4
7	6.6193	-21.5530	0.2250	3.0112	3.0380	572.469
8	-9.1618	4.8455	0.6370	3.0380	3.0772	
9	-6.5726	1.1994	0.0200			SK2
10	1.1994	-10.0217	0.4800	3.0815	3.0396	
			0.1000*2			
			0.1500	1.3327	1.3175	LAK8
			0.1050			
			0.1500	1.3196	1.3710	LAK8
			0.3000	1.3716	1.3788	715.421
			6.9581*3			
			Aperture Stop			
11	-6.3533	3.1648	0.2250	2.4140	2.5756	KZFS5
12	3.1648	-3.6610	0.6000	2.5756	2.6276	602.612
13	7.3996	-1.9085	0.0200			
14	-1.9085	-7.3276	0.8000	2.6870	2.6850	605.505
15	-7.6787	2.0988	0.2250	2.6850	2.6805	KZFS1
16	2.0988	-47.4687	0.3231*4	2.5987	2.5916	KZFS5
			0.6000	2.5916	2.5809	733.285
			0.1000			
17	-30.8523	5.1767	0.2250	2.5647	2.5364	LAK8
18	-13.1762	11.9115	7.0506*5			
19	11.9115	-9.8489	0.3000	4.1988	4.3855	SF8
20	18.9805	-11.2859	0.8000	4.3855	4.4942	585.588
			0.0200			
21	-6.8253	84.7684	0.6000	4.5943	4.6064	SK2
22	84.7684	-8.3245	0.5935*6			
			0.3000	4.5416	4.7047	F4
			0.8500	4.7047	4.8054	SK2
			0.0200			
23	16.3218	-17.1055	0.7000	4.9004	4.9298	SK2
			12.0000			

Note: Positive radius indicates the center of curvature is to the right; negative radius indicates the center of curvature is to the left. See next page for zoom parameters (*).

SPECIFICATION FOR 5X TO 100X ZOOM PROJECTION LENS (continued)

Zoom Parameters	Pos. 1	Pos. 2	Pos. 3	Pos. 4	Pos. 5	Pos. 6	Pos. 7
*1	7.0719	5.9559	4.8394	3.7231	2.6068	1.4905	0.3639
*2	0.1000	1.2163	2.3326	3.4488	4.5651	5.6814	6.8081
*3	6.9581	5.8418	4.7255	3.6092	2.4929	1.3767	0.2500
*4	0.3231	1.4394	2.5557	3.6720	4.7883	5.9046	7.0312
*5	7.0505	5.9342	4.8179	3.7016	2.5853	1.4690	0.3424
*6	0.5935	1.7098	2.8260	3.9423	5.0586	6.1749	7.3015
<hr/>							
EFL	0.8306	1.3525	2.2290	3.7067	6.1950	10.3195	16.8889
BFL	11.9941	11.9806	11.9408	11.8356	11.5369	10.6852	8.5572
FEL	6.0649	6.2227	6.4912	6.9085	7.4663	7.9428	7.4447
P/MO	2.5919	3.9506	6.0642	9.3146	14.2003	21.2407	30.8528
Reflection	0.0100	0.0163	0.0267	0.0442	0.0733	0.1215	0.2000
Finite F/No.	2.6178	4.0148	6.2261	9.7261	15.2418	23.8212	37.0233
Obj Distance	77.0000	77.0000	77.0000	77.0000	77.0000	77.0000	77.0000
Image Distance	12.0024	12.0026	12.0003	11.9994	11.9913	11.9389	11.9350
Total Track	135.0241	135.0241	135.0241	135.0241	135.0241	135.0241	135.0241
OAL	46.0241	46.0241	46.0241	46.0241	46.0241	46.0241	46.0241
Sent-Field	10.2403	10.2281	10.2081	10.1784	10.1381	10.0902	7.5750
Entr Pupil Diameter	0.3171	0.3364	0.3570	0.3793	0.4033	0.4294	0.4566
Entr Pupil Distance	6.0070	6.1048	6.2635	6.4985	6.8156	7.1894	7.5222
Exit Pupil Diameter	4.5439	3.8597	3.4949	3.4287	3.8401	5.8812	99.5131
Exit Pupil Distance	23.8976	27.4936	33.7602	45.3472	70.5215	152.0372	-3672.3718

THIS REPORT HAS BEEN DELIMITED
AND CLEARED FOR PUBLIC RELEASE
UNDER DOD DIRECTIVE 5200.20 AND
NO RESTRICTIONS ARE IMPOSED UPON
ITS USE AND DISCLOSURE.

DISTRIBUTION STATEMENT A

APPROVED FOR PUBLIC RELEASE,
DISTRIBUTION UNLIMITED.